Fishery Data Series No. 97-10

Stock Assessment of the Return of Early-run Chinook Salmon to the Kenai River, 1996

by

S. L. Hammarstrom

May 1997

Alaska Department of Fish and Game **Division of Sport Fish**

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd

Spell out acre and ton.

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s

Spell out year, month, and week.

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
id est (that is)	i.e.,
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, χ^2, etc.
confidence interval	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
standard length	SL
total length	TL
variance	Var

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STOCK ASSESSMENT OF THE RETURN OF EARLY-RUN CHINOOK SALMON TO THE KENAI RIVER, 1996

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure **Page**

LIST OF APPENDICES

ABSTRACT

The total inriver return of early-run (May and June) chinook salmon *Oncorhynchus tshawytscha* as estimated through hydroacoustic techniques was 23,505 (SE = 376) fish. Angler effort and harvest as estimated by a creel survey during the early chinook salmon run in the downstream section (Cook Inlet to the Soldotna Bridge) were 130,180 (SE = 3,914) angler hours and 4,166 (SE = 290) chinook salmon, respectively. When expanded to account for the unsurveyed portion of the fishery, total estimated effort and harvest were 185,921 angler-hours and 5,966 (SE = 442) fish, respectively; approximately equal to the 1974-1995 mean. Estimated release mortality was 241 (SE = 136) fish. Spawning escapement, estimated by subtracting total fishing mortality from total inriver return, was 17,298 (SE = 596) fish. This escapement was nearly double that stipulated by the Kenai River Early King Salmon Management Plan. The predominant age class of both the inriver return and the recreational harvest of early-run chinook salmon was age-1.4 fish.

Migratory timing models were used to project spawning escapement during the 1996 fishery. No restrictions to the recreational fishery were required to achieve the escapement.

A model based on sibling ratios was used to forecast the 1997 return at 31,622 (SE = 9,324) chinook salmon.

Key words: Kenai River, chinook salmon, creel survey, effort, harvest, migratory timing, sibling ratios, brood tables, *Oncorhynchus tshawytscha*, forecast.

INTRODUCTION

The largest freshwater recreational fishery in Alaska occurs in the Kenai River with an average of nearly 350,000 angler-days of effort each year from 1983-1995 (Mills 1984-1994; Howe et al. 1995, 1996). This represents approximately 15% of the state's recreational fishing effort. The majority of the angler-effort occurs during May, June, and July, downstream of the outlet of Skilak Lake to Cook Inlet (river kilometer 13 to river kilometer 81) (Figure 1) during a fishery directed primarily at returning chinook salmon *Oncorhynchus tshawytscha*.

Two stocks of chinook salmon return to the Kenai River: an early run which enters the river from mid-May through June, and a late run which enters the river from late June through early August (Burger et al. 1985, Bendock and Alexandersdottir 1992). Early-run fish are destined primarily for tributary spawning locations (Bendock and Alexandersdottir 1992) and are the focus of this report. Late-run fish are destined almost exclusively for mainstem spawning locations.

Prior to 1970, the recreational fishery in the Kenai River comprised shorebased anglers targeting sockeye salmon *O. nerka* in July and coho salmon *O. kisutch* in August and early September. In 1973, large numbers of anglers began experimenting with a fishing method that involved bouncing brightly colored terminal gear along the river bottom from a drifting boat. This technique had been used effectively by anglers fishing for chinook salmon on rivers in the Pacific Northwest. It proved to be a very effective method for catching chinook salmon on the Kenai River, and the fishery expanded rapidly (Figure 2).

As fisheries targeting both the early and late runs of chinook salmon continued to grow during the early 1980s, agency and public concerns about overexploitation were heightened. In 1988, the Board of Fisheries (BOF) adopted management plans for the early- and late-run returns of chinook salmon to the Kenai River (McBride et al. 1989). These plans, in effect since 1989, stipulate specific escapement goals for which the fisheries will be managed, and how these fisheries will be managed in the event of conservation shortfall.

For management purposes, chinook salmon entering the Kenai River prior to 1 July are considered to be early-run fish; those entering

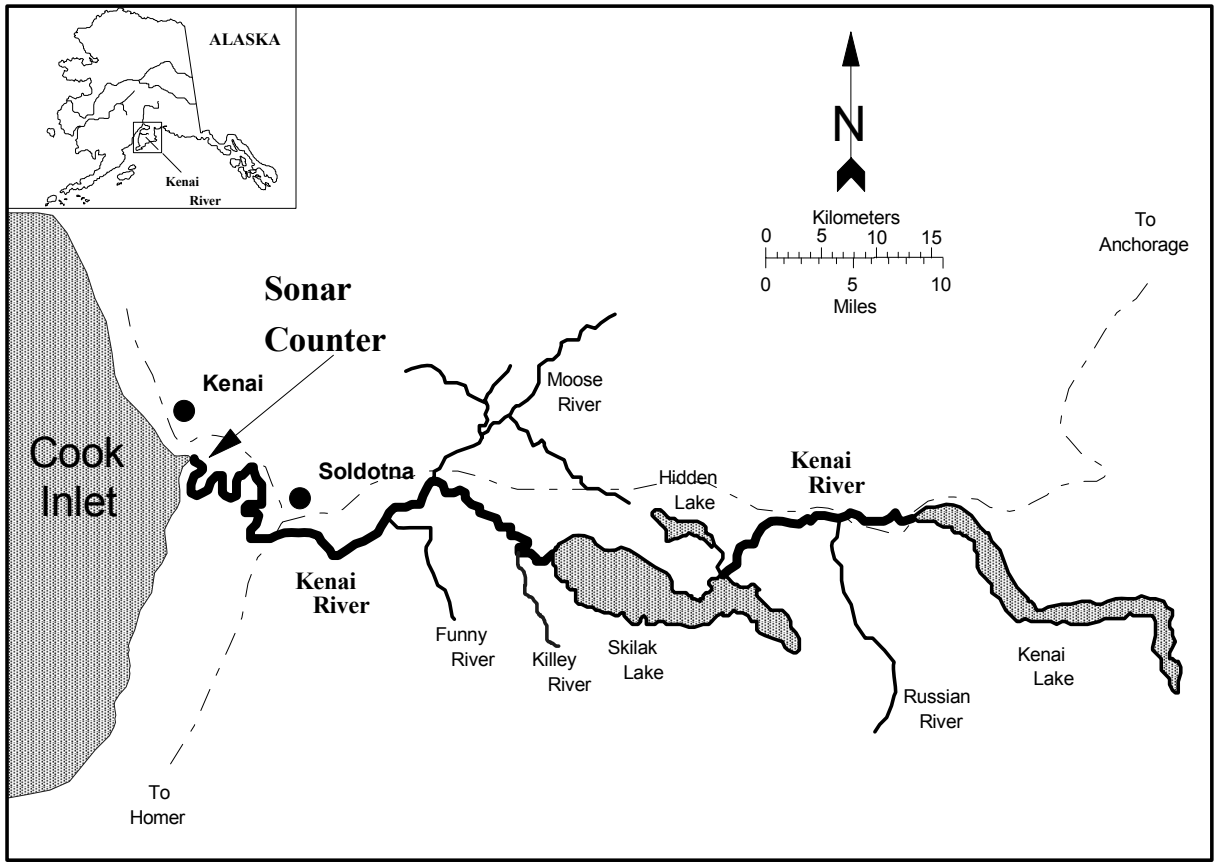

Figure 1.-Map of the Kenai River drainage.

after 30 June are late-run fish. The Kenai River Early King Salmon Management Plan stipulates that the use of bait is prohibited from 1 January until an estimated optimum spawning escapement level of 9,000 fish is projected (Figure 3). If the projected spawning escapement is between 5,300 and 9,000 fish, the department shall, by emergency order, restrict the fishery through bag limit reduction and/or time/area closure to achieve 9,000 fish in the escapement. If the projected escapement is less than 5,300, chinook salmon fishing is to be prohibited until 1 July downstream of the Funny River and 10 July upstream of the Funny River (Figure 1 and Figure 3). A 1990 amendment to the plan, which was implemented in 1992, allowed retention of fish 132 cm (52 in) or larger if hook-and-release fishing was imposed (hereafter referred to as trophy fishing).

Sport fishing regulations for chinook salmon in the Kenai River are also detailed in the management plans, and are now among the most restrictive in Alaska. Only the mainstem Kenai River between the outlet of Skilak Lake and Cook Inlet (Figure 1) is open to fishing for chinook salmon. By regulation, the season for chinook salmon is from 1 January through 31 July, but it effectively begins in mid-May when the fish first begin entering the river. The daily bag and possession limits are one chinook salmon per day greater than 41 cm (16 in) total length and a seasonal limit of two chinook salmon greater than 41 cm. In 1992, the BOF closed two areas on the Kenai

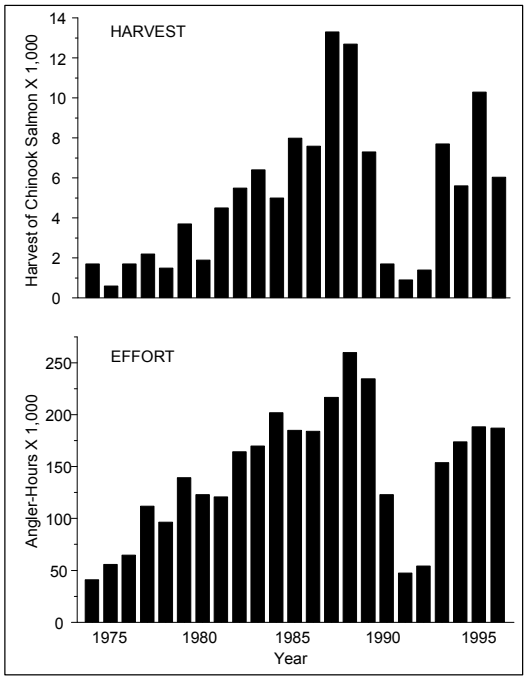

Figure 2.-Historical harvest and effort in the recreational fishery for early-run chinook salmon, Kenai River, 1974-1996.

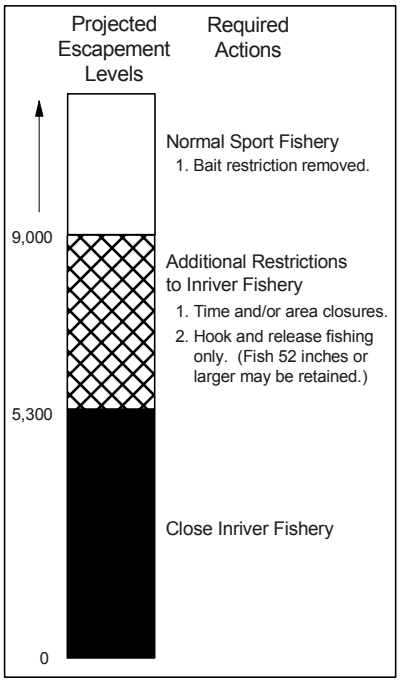

Figure 3.-Escapement levels and required actions according to the Kenai River Early Run Chinook Salmon Management Plan.

River to fishing from a boat: the vicinity of the confluence with Slikok Creek, and the confluence with the Funny River. Fishing from boats is not allowed in these areas from 1 January to 15 July. Fishing from boats downstream from the outlet of Skilak Lake is prohibited on Mondays in May and June except Memorial Day. Anyone retaining a chinook salmon 41 cm in length or greater is prohibited from fishing from a boat in the Kenai River downstream of Skilak Lake for the remainder of that day. There are additional restrictions placed on anglers using professional guides: fishing from a guided boat is allowed only between 0600 and 1800 hours during June and July. Anglers using guides during May are not restricted.

Implementation of the management plan hinges upon the department's ability to project the strength of the current year's return early in the season. A comprehensive stock assessment program, initiated in the mid-1980s in response to the growing chinook salmon fisheries, and creel surveys, which have been conducted on the Kenai River since 1974, are the primary means of collecting the data necessary for implementing the plans. The objectives of these continuing studies are two-fold: to assess production by estimating harvest and inriver returns by age (Hammarstrom and Larson 1986)[1]; and to model run timing, including migratory timing

[1] To clarify terms, inriver return refers to all fish that are counted by sonar in the Kenai River. Total return refers to all early-run Kenai River chinook salmon harvested in Upper Cook Inlet marine fisheries (recreational and educational) plus the inriver return.

estimates of effort, harvest, and abundance. Because of the diversity and complexity of these studies, results of each study are published in separate reports.

This report compiles statistics for the 1996 early-run return, including estimates of inriver return, fishery statistics, and escapement. The estimates are compared to historic data and their application to the 1996 return are discussed. Finally a forecast of the 1997 return is presented.

Previous studies of the chinook salmon fisheries in the Kenai River include the following: King (1995-1996), Hammarstrom (1975-1981, 1988-1991, 1992a and b, 1993a and b, 1994a and b), Hammarstrom and Larson (1982-1984, 1986), Hammarstrom et al. (1985, 1987), and Conrad and Hammarstrom (1987). Details of the 1996 creel survey of the recreational fishery are reported by King (1997). Angler-effort and harvest by species for the recreational fishery have been estimated by Mills (1979-1994) and Howe et al. (1995, 1996) through the Statewide Harvest Survey (SWHS), a postal questionnaire. Rationale for the escapement goals and migratory timing data to implement the management plans are contained in McBride et al. (1989). Bendock and Alexandersdottir (1992) estimated hooking mortality for the Kenai River chinook salmon recreational fisheries. Estimates of total return by age have been summarized through 1990 by Sonnichsen and Alexandersdottir (1991) and 1991-1995 by Hammarstrom (1992b, 1993b, 1994b, 1995, 1996).

SUMMARY OF HISTORICAL DATA

HARVEST AND ESCAPEMENT

Early-run Kenai River chinook salmon migrate, as adults, back to Cook Inlet with other stocks of chinook salmon from numerous natal streams of the Kenai Peninsula (Anchor River, Deep Creek, Ninilchik River, Stariski Creek, and Kasilof River) and the Susitna River drainage. Since the 1980s, Susitna River fish routinely outnumber the early-run Kenai River fish by an order of magnitude (McBride et al. 1985).

During May and June, the recreational marine fishery along the eastern shore of Cook Inlet, near Ninilchik Village, accounts for the only significant marine harvest of these stocks. The harvest in this fishery during May and June averaged about 2,500 fish from 1972-1990 (Hammarstrom and Larson 1986; Hammarstrom et al. 1987; Mills 1988-1991; Sonnichsen and Alexandersdottir 1991). Estimates of harvest from an onsite creel survey were 5,577 (SE = 237) chinook salmon in 1994 and 6,048 (SE = 228) chinook salmon in 1995 (McKinley 1995, 1996).

An educational gillnet fishery operated in Cook Inlet by the Kenaitze Indian tribe has accounted for less than 120 fish annually. A subsistence gillnet fishery, established by the BOF in 1992, harvested 238 chinook salmon in 1992, 406 chinook salmon in 1994, and 738 chinook salmon in 1995. This fishery was closed in 1993, reinstituted in 1994, and prosecuted as a personal use fishery in 1995. Based on available information, it is unlikely that other unknown harvests of early-run chinook salmon of Kenai River origin are large enough to alter conclusions regarding the status of this stock (McBride et al. 1989). However, the marine sport fishery has increased in recent years, and may thus increase in importance.

Catch and harvest of chinook salmon in the Kenai River recreational fishery are estimated with an onsite creel survey (Hammarstrom 1975-1981, 1988-1991, 1992a, 1993a, 1994a; Hammarstrom and Larson 1982-1984, 1986; Hammarstrom et al. 1985; Conrad and Hammarstrom 1987; King 1995-1997). The creel survey only provides estimates from the

Soldotna Bridge to Cook Inlet. Prior to 1995, estimates for the area upstream of the Soldotna Bridge were made using information from years the upstream area was surveyed (Hammarstrom 1993a, 1994a, 1995). But these estimates appeared biased, so catch and harvest are now estimated using a regressions model based on the exploitation rate in the Soldotna Bridge to Cook Inlet area (Appendix A3).

Inriver returns have been estimated using two methods: a hydroacoustic (sonar) program from 1984-1995 (Eggers et. al 1995; Burwen and Bosch 1995a, 1995b, 1996, *In prep*); and a capture-recapture program from 1985-1990 (Hammarstrom and Larson 1986; Conrad and Larson 1987; Conrad 1988; Carlon and Alexandersdottir 1989; Alexandersdottir and Marsh 1990). The programs were conducted simultaneously from 1985-1990 to determine the best method for estimating inriver return. The sonar program was exploratory during the first 4 years of the study, and thus, sonar estimates for 1984-1987 are not used for stock assessment. Estimates from the capture-recapture study are used for stock assessment for 1985-1987. Beginning in 1988, sonar estimates are used because they are more precise than the capture-recapture estimates. In addition, the Management Plan implemented in 1989 requires inseason estimates of abundance which could not be provided by the capture-recapture method. The capture-recapture program was terminated after 1990 because estimates from the two methods were similar but the sonar estimates continued to be more precise and redundancy was cost prohibitive. Since 1985, the inriver return has averaged 18,591 chinook salmon.

To estimate abundance by age, the age/sex composition of the inriver return is sampled. Prior to 1991, scale samples collected from chinook salmon captured with large mesh gillnets during capture-recapture studies provided the samples for this analysis. Although the tagging program was discontinued in 1991, age, sex, and length samples are still collected using gillnets. All fish captured with gillnets are sampled for age, sex, and size. Size selectivity analysis has not been conducted.

Harvest by age and sex, and catch of chinook salmon in the early-run fishery are estimated through a creel survey (Hammarstrom 1975-1981, 1988-1991, 1992a, 1993a, 1994a; Hammarstrom and Larson 1982-1984, 1986; Hammarstrom et al. 1985; Conrad and Hammarstrom 1987; King 1995-1997). Chinook salmon are sampled during angler interviews conducted in the creel survey (Hammarstrom 1992a). Age composi-tion of the harvest upstream of the Soldotna Bridge was assumed equal to that in the surveyed area.

Mortality from hook-and-release fishing on early-run fish was an estimated 11.1% for small males (< 750 mm), 1.9% for large males (> 750 mm), and 6.8% for females (Bendock and Alexandersdottir 1992). Because it is not possible to measure the size or sex composition of the release component, a grand average of the estimated mortality rate on early-run fish (6.4%) was used as a reasonable estimate for this stock. This approach introduces an unknown bias because of the higher mortality for small males and the tendency of anglers to release smaller fish. To complete tabulations of return by age, I used the age and sex composition of the inriver return as an approximation of the chinook salmon released in the recreational fishery.

Escapement (fish that survive all fisheries and are potential spawners) is estimated by subtracting the inriver sport harvest and the hook-and-release mortalities from the inriver return.

BROOD AND SIBLING RATIOS

Chinook salmon in the Kenai River are managed to achieve optimum sustained production. In 1988, spawning requirements were computed to sustain levels of production realized during the years 1984-1988. These escapement goals were based on limited information from the Kenai River and experiences of other researchers working with chinook salmon on the west coast of North America (McBride et al. 1989). Total return data are being compiled to assess production and refine these escapement goals. A good stock-recruit analysis requires data that span decades, since one year's return must be compared to returns from parent generations many years earlier.

A predictable relationship between consecutive-year returns of the same brood (i.e. sibling relationship) has been established for the early run (Sonnichsen and Alexandersdottir 1991). As a result, mean sibling ratios (the ratio of the returns of one age to the returns of one or more younger ages for a brood) for years with complete return data were used to predict returns for 1990-1996 (Sonnichsen and Alexandersdottir 1991; Hammarstrom 1992b, 1993b, 1994b, 1995, 1996). Sibling ratios were updated with the analysis of the 1996 return to forecast the 1997 return (Appendix A1).

MIGRATORY TIMING

Inriver return (measured by capture-recapture experiments in 1985-1987 and by sonar in 1988-1996) and inriver recreational fishery statistics (effort, harvest per hour, catch per hour, harvest, and catch) are used to estimate the migratory timing of the chinook salmon return into the Kenai River. Historic cumulative daily proportions of each of these statistics are applied to data from the year in question to predict season-end values (Appendix A2; McBride et al. 1989). Cumulative daily sonar counts were divided by average cumulative daily proportions of the inriver return for the years 1985-1995 to project the total inriver return for 1996 (Appendix B1). Similarly, the recreational effort, harvest and catch were projected using the inseason estimates of each parameter and average cumulative proportion data from 1986-1995 (Appendices B2-B7).

Escapement was projected by subtracting the projected fishing mortality (harvest + hook-and-release mortality) from the projected inriver return. Although projections are made from the commencement of the fishery, precision of the estimates is insufficient to detect significant deviations from the average historic migratory timing until early June.

ASSESSMENT OF THE 1996 EARLY RETURN

INRIVER RETURN

The sonar began counting fish 16 May 1996 and continued through the early run (Burwen and Bosch *In prep*). The 1996 inriver return through 30 June was 23,505 (SE = 376) chinook salmon (Table 1). The 1996 return was the largest return since 1987 and the third largest return since 1985.[2]

A total of 331 chinook salmon was captured in the gillnet test fishery during the early run (Table 2). No temporal differences (χ^2 = 0.17, df = 1, P = 0.68; 16 May-7 June vs. 8 June-30 June) were detected for the two age groups that composed 90% of the return and thus all samples were pooled. Total inriver

[2] Inriver return was estimated with tagging data in 1985 (15,972), 1986 (27,080) and 1987 (25,643). See Table 8 for a summary of all return data.

Table 1.-Historical sonar counts of chinook salmon in the Kenai River during the early run, 1987-1996.

	1987 Counts		1988 Counts		1989 Counts		1990 Counts		1991 Counts		1992 Counts		1993 Counts		1994 Counts		1995 Counts		1996 Counts	
Date	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
5/16			188	188	180	180	78	78	30	30	54	54	85	85	238	238	98	98	60	60
5/17			415	603	319	499	57	135	12	42	48	102	91	176	342	580	99	197	91	151
5/18			259	862	264	763	93	228	65	107	88	190	66	242	260	840	78	275	63	214
5/19			260	1,122	180	943	136	364	55	162	40	230	69	311	302	1,142	149	424	96	310
5/20			406	1,528	147	1,090	93	457	68	230	78	308	165	476	369	1,511	228	652	177	487
5/21			184	1,712	245	1,335	69	526	51	281	90	398	117	593	327	1,838	465	1,117	165	652
5/22			182	1,894	164	1,499	75	601	111	392	108	506	155	748	246	2,084	265	1,382	156	808
5/23			231	2,125	186	1,685	63	664	66	458	150	656	141	889	212	2,296	286	1,668	159	967
5/24			288	2,413	279	1,964	51	715	66	524	126	782	150	1,039	303	2,599	265	1,933	159	1,126
5/25			351	2,764	300	2,264	76	791	57	581	79	861	168	1,207	170	2,769	198	2,131	153	1,279
5/26			393	3,157	270	2,534	70	861	81	662	93	954	150	1,357	150	2,919	189	2,320	240	1,519
5/27			387	3,544	419	2,953	87	948	81	743	66	1,020	322	1,679	267	3,186	165	2,485	204	1,723
5/28			483	4,027	357	3,310	61	1,009	78	821	78	1,098	488	2,167	258	3,444	159	2,644	330	2,053
5/29			713	4,740	269	3,579	144	1,153	51	872	45	1,143	340	2,507	347	3,791	222	2,866	512	2,565
5/30			333	5,073	164	3,743	138	1,291	51	923	111	1,254	266	2,773	321	4,112	351	3,217	348	2,913
5/31			501	5,574	157	3,900	173	1,464	69	992	114	1,368	185	2,958	369	4,481	282	3,499	474	3,387
6/01			556	6,130	258	4,158	153	1,617	150	1,142	106	1,474	389	3,347	321	4,802	357	3,856	603	3,990
6/02			545	6,675	194	4,352	303	1,920	240	1,382	107	1,581	324	3,671	266	5,068	369	4,225	740	4,730
6/03			598	7,273	233	4,585	235	2,155	362	1,744	232	1,813	255	3,926	298	5,366	549	4,774	873	5,603
6/04	1,059	1,059	755	8,028	246	4,831	177	2,332	177	1,921	190	2,003	276	4,202	304	5,670	693	5,467	1,051	6,654
6/05	552	1,611	782	8,810	280	5,111	192	2,524	316	2,237	166	2,169	327	4,529	351	6,021	429	5,896	943	7,597
6/06	1,495	3,106	493	9,303	384	5,495	156	2,680	290	2,527	319	2,488	198	4,727	198	6,219	807	6,703	741	8,338
6/07	1,145	4,251	506	9,809	545	6,040	304	2,984	215	2,742	515	3,003	297	5,024	384	6,603	843	7,546	772	9,110
6/08	602	4,853	771	10,580	890	6,930	415	3,399	244	2,986	375	3,378	378	5,402	306	6,909	999	8,545	918	10,028
6/09	1,024	5,877	569	11,149	912	7,842	330	3,729	447	3,433	486	3,864	453	5,855	462	7,371	789	9,334	1,140	11,168
6/10	985	6,862	333	11,482	913	8,755	270	3,999	281	3,714	264	4,128	549	6,404	432	7,803	876	10,210	684	11,852
6/11	1,004	7,866	320	11,802	710	9,465	453	4,452	335	4,049	234	4,362	600	7,004	423	8,226	774	10,984	882	12,734
6/12	1,044	8,910	302	12,104	577	10,042	569	5,021	388	4,437	394	4,756	951	7,955	329	8,555	417	11,401	864	13,598
6/13	2,168	11,078	188	12,292	599	10,641	444	5,465	360	4,797	236	4,992	812	8,767	376	8,931	492	11,893	1,071	14,669
6/14	1,297	12,375	289	12,581	458	11,099	330	5,795	272	5,069	174	5,166	406	9,173	514	9,445	691	12,584	1,111	15,780

-continued-

Table 1.-Page 2 of 2.

Date	1987 Counts		1988 Counts		1989 Counts		1990 Counts		1991 Counts		1992 Counts		1993 Counts		1994 Counts		1995 Counts		1996 Counts	
	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
6/15	975	13,350	510	13,091	335	11,434	651	6,446	432	5,501	312	5,478	617	9,790	306	9,751	636	13,220	1,116	16,896
6/16	786	14,136	808	13,899	397	11,831	486	6,932	610	6,111	239	5,717	567	10,357	453	10,204	648	13,868	420	17,316
6/17	612	14,748	535	14,434	514	12,345	277	7,209	335	6,446	339	6,056	606	10,963	315	10,519	750	14,618	495	17,811
6/18	783	15,531	533	14,967	464	12,809	238	7,447	494	6,940	320	6,376	425	11,388	435	10,954	808	15,426	697	18,508
6/19	771	16,302	200	15,167	295	13,104	332	7,779	440	7,380	390	6,766	504	11,892	636	11,590	419	15,845	657	19,165
6/20	682	16,984	175	15,342	498	13,602	369	8,148	317	7,697	548	7,314	621	12,513	402	11,992	594	16,439	315	19,480
6/21	517	17,501	373	15,715	520	14,122	256	8,404	454	8,151	372	7,686	399	12,912	570	12,562	438	16,877	351	19,831
6/22	487	17,988	312	16,027	614	14,736	265	8,669	438	8,589	297	7,983	608	13,520	366	12,928	375	17,252	396	20,227
6/23	529	18,517	375	16,402	547	15,283	240	8,909	398	8,987	213	8,196	720	14,240	550	13,478	178	17,430	401	20,628
6/24	303	18,820	674	17,076	564	15,847	322	9,231	250	9,237	337	8,533	808	15,048	696	14,174	450	17,880	573	21,201
6/25	564	19,384	582	17,658	374	16,221	258	9,489	225	9,462	362	8,895	1,050	16,098	734	14,908	429	18,309	684	21,885
6/26	731	20,115	436	18,094	369	16,590	322	9,811	271	9,733	330	9,225	1,156	17,254	597	15,505	334	18,643	504	22,389
6/27	452	20,567	549	18,643	309	16,899	231	10,042	340	10,073	291	9,516	797	18,051	639	16,144	946	19,589	228	22,617
6/28	587	21,154	827	19,470	425	17,324	236	10,278	330	10,403	253	9,769	732	18,783	681	16,825	696	20,285	303	22,920
6/29	371	21,525	495	19,965	376	17,700	208	10,486	258	10,661	121	9,890	657	19,440	929	17,754	984	21,269	234	23,154
6/30	388	21,913	915	20,880	292	17,992	193	10,679	270	10,931	197	10,087	481	19,921	649	18,403	615	21,884	351	23,505
TOTAL		21,913		20,880		17,992		10,679		10,931		10,087		19,921		18,403		21,884		23,505

Table 2.-Estimates by age class of the number of early-run chinook salmon in the inriver return to the Kenai River, 1996.

	Age Class					
	1.2	1.3	1.4	1.5	Other	Total
(5/16 - 6/30)						
Males						
Sample Size	23	63	89	6	0	181
Percent	6.9	19.0	26.9	1.8	0.0	54.7
SE Percent	1.4	2.2	2.4	0.7	0.0	2.7
Return	1,633	4,474	6,320	426	0	12,853
SE Return	330	513	582	173	0	676
Females						
Sample Size	3	32	114	1	0	150
Percent	0.9	9.7	34.4	0.3	0.0	45.3
SE Percent	0.5	1.6	2.6	0.3	0.0	2.7
Return	213	2,272	8,095	71	0	10,652
SE Return	123	384	628	71	0	666
Combined						
Sample Size	26	95	203	7	0	331
Percent	7.9	28.7	61.3	2.1	0.0	100.0
SE Percent	1.5	2.5	2.7	0.8	0.0	
Return	1,846	6,746	14,415	497	0	23,505
SE Return	349	595	671	186	0	376

return by age and historical age compositions (1986-1996) are presented in Table 3.

RECREATIONAL FISHERY

The 1996 creel survey commenced on 16 May (King 1997). A relatively strong return from the start of the sonar operation precluded any additional restrictive regulations on the recreational fishery. Effective 9 June, an emergency order removed the bait restriction because inseason forecasts predicted the minimum escapement would be attained.

Estimated angler effort for early-run chinook salmon in the downstream section (Cook Inlet to the Soldotna Bridge) was 130,180 angler-hours (SE = 3,914); estimated catch was 5,552 (SE = 320) chinook salmon and estimated harvest was 4,166 (SE = 290) fish (King 1997).

The estimated 1996 harvest in the area between the Soldotna Bridge and Moose River was 1,121 (SE = 118). Harvest upstream of the Moose River in 1996 was 679 fish (SE = 312). Estimated catch from the Soldotna Bridge to Moose River was 2,605 (SE = 37) chinook salmon; and 1,574 (SE = 656) fish for the area upstream of Moose River.

Total estimated harvest was 5,966 (SE = 442) chinook salmon (Table 4). Anglers employing professional guides accounted for 76% of the harvest and 55% of the effort.

Age composition of the recreational harvest was determined from 288 fish harvested during the early run. No temporal differences ($\chi^2 = 3.33$, df = 2, P = 0.19) were detected for the two age groups that composed 90% of the

Table 3.-Estimates by age class of the number of early-run chinook salmon in the total return to the Kenai River, 1986-1996.

	Age Class									
	1.1	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	Total
1986										
Percent	0.0	16.8	43.3	32.8	7.0	0.0	0.0	0.0	0.0	100.0
Return	0	4,554	11,731	8,880	1,908	0	0	0	7	27,080
SE Return	0	1,755	4,239	3,195	703	0	0	0	12	9,799
1987										
Percent	0.0	1.5	37.6	58.0	2.3	0.0	0.0	0.1	0.4	100.0
Return	0	386	9,653	14,883	589	0	0	31	101	25,643
SE Return	0	125	2,080	3,732	226	0	0	31	56	5,928
1988										
Percent	0.0	1.7	14.8	72.2	10.9	0.3	0.0	0.1	0.0	100.0
Return	0	358	3,088	15,077	2,279	57	0	21	0	20,880
SE Return	0	97	260	335	237	40	0	21	0	0
1989										
Percent	0.0	4.2	15.8	70.8	9.2	0.0	0.0	0.0	0.0	100.0
Return	0	759	2,853	12,788	1,665	0	0	0	0	18,065 [a]
SE Return	0	137	250	311	195	0	0	0	0	0
1990										
Percent	0.0	7.4	26.1	60.5	6.0	0.0	0.0	0.0	0.0	100.0
Return	0	793	2,796	6,487	643	0	0	0	0	10,719 [b]
SE Return	0	132	212	239	113	0	0	0	0	0
1991										
Percent	0.0	7.3	22.4	65.1	5.2	0.0	0.0	0.0	0.0	100.0
Return	0	801	2,450	7,117	565	0	0	0	0	10,933 [c]
SE Return	0	187	300	343	159	0	0	0	0	0

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Table 3.-Page 2 of 2.

	Age Class									
	1.1	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	Total
1992										
Percent	0.0	8.1	28.5	58.1	5.3	0.0	0.0	0.0	0.0	100.0
Return	0	826	2,891	5,906	537	0	0	0	0	10,160 [d]
SE Return	0	177	293	320	145	0	0	0	0	0
1993										
Percent	0.0	3.9	25.1	66.3	3.7	0.0	0.4	0.5	0.0	100.0
Return	0	784	5,039	13,281	750	0	83	102	0	20,039 [e]
SE Return	0	231	501	552	228	0	83	59	0	
1994										
Percent	0.0	3.6	19.9	69.1	4.4	0.0	0.2	0.7	2.1	100.0
Return	0	662	3,675	12,758	809	0	44	122	389	18,459 [f]
SE Return	0	163	346	402	181	0	44	72	129	
1995										
Percent	0.0	5.7	23.7	66.4	3.5	0.0	0.0	0.0	0.7	100.0
Return	0	1,249	5,195	14,556	767	0	0	0	153	21,920 [g]
SE Return	0	389	697	762	262	0	0	0	153	
1996										
Percent	0.0	7.9	28.7	61.3	2.1	0.0	0.0	0.0	0.0	100.0
Return	0	1,847	6,750	14,424	497	0	0	0	0	23,519 [h]
SE Return	0	349	595	671	186	0	0	0	0	376

[a] Includes 73 fish harvested in the Kenaitze educational gillnet fishery.

[b] Includes 40 fish harvested in the Kenaitze educational gillnet fishery.

[c] Includes two fish harvested in the Kenaitze educational gillnet fishery.

[d] Includes 47 fish harvested in the Kenaitze educational gillnet fishery and 26 fish harvested in the subsistence dip net fishery.

[e] Includes 118 fish harvested in the Kenaitze educational gillnet fishery.

[f] Includes 56 fish harvested in the Kenaitze educational gillnet fishery.

[g] Includes 37 fish harvested in the Kenaitze educational gillnet fishery.

[h] Includes 14 fish harvested in the Kenaitze educational gillnet fishery.

Table 4.-Historical summary of harvest, angler effort and harvest rate in the recreational fishery for early-run chinook salmon, Kenai River, 1974-1996.

	Harvest			Effort in Angler Hours			Harvest per Hour		
Year	Unguided	Guided	Total	Unguided	Guided	Total	Unguided	Guided	Total
1974			1,685			41,098			0.041
1975			615			55,909			0.011
1976			1,665			64,750			0.026
1977			2,173			112,007			0.019
1978			1,542			96,624			0.016
1979			3,661			139,154			0.026
1980			1,946			123,019			0.016
1981	2,278	2,247	4,525	92,837	28,044	120,881	0.025	0.080	0.037
1982	3,002	2,464	5,466	136,560	27,774	164,334	0.022	0.089	0.033
1983	2,274	4,086	6,360	121,208	48,789	169,997	0.019	0.084	0.037
1984	2,396	2,560	4,956	153,586	48,235	201,821	0.016	0.053	0.025
1985	3,191	4,780	7,971	126,243	58,593	184,836	0.025	0.082	0.043
1986	3,575	3,986	7,561	134,868	49,033	183,901	0.027	0.081	0.041
1987	6,899	6,382	13,281	160,839	55,977	216,816	0.043	0.114	0.061
1988	5,791	6,956	12,747	181,436	78,465	259,901	0.032	0.089	0.049
1989	1,952	5,304	7,256	132,282	102,245	234,527	0.015	0.052	0.031
1990 [a]	367	1,368	1,735	57,189	65,960	123,149	0.010	0.038	0.024
1991 [a]	298	593	891	24,320	23,279	47,599	0.020	0.043	0.031
1992 [a]	653	712	1,365	28,217	26,113	54,330	0.036	0.052	0.043
1993	2,784 [b]	4,062 [b]	7,727	76,500 [b]	46,773 [b]	153,899	0.036 [b]	0.087 [b]	0.056 [b]
1994	1,524 [c]	3,198 [c]	5,634	72,433 [c]	61,766 [c]	173,842	0.021 [c]	0.052 [c]	0.035 [c]
1995	3,009 [d]	4,724 [d]	10,327	90,073 [d]	75,917 [d]	188,161	0.033 [d]	0.062 [d]	0.047 [d]
Mean	2,666	3,561	6,520	105,906	53,131	165,200	0.025	0.070	0.040
1996	981 [e]	3,185 [e]	5,966	58,551 [e]	71,629 [e]	185,921	0.017 [e]	0.045 [e]	0.032 [e]

[a] Harvest per hour only for periods open to retention of chinook salmon. Periods of trophy fishing (i.e. only fish greater than 52 inches may be retained) are excluded.

[b] Estimates presented are for the downstream section only. Total harvest was expanded by 881 fish to account for harvest upstream of the survey area. Total effort was expanded by 30,626 angler hours to account for effort upstream of the survey area. Expansion was based on the average proportion of harvest and effort occurring in the upstream section from 1986-1989.

[c] Estimates presented are for the downstream section only. Total harvest was expanded by 912 fish to account for harvest upstream of the survey area. Total effort was expanded by 39,643 angler hours to account for effort upstream of the survey area. Expansion was based on the average proportion of harvest and effort occurring in the upstream section from 1986-1989.

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Table 4.-Page 2 of 2.

[d] Estimates presented are for the downstream section only. Total harvest was expanded by 2,594 fish to account for harvest upstream of the survey area. Total effort was expanded by 22,171 angler hours to account for effort upstream of the survey area. Harvest expansion was based on an exploitation relationship for the years 1987-1993 from the SWHS. Effort expansion used the estimated harvest and the harvest-per-hour data collected from completed anglers during the 1995 fishery in the upstream area.

[e] Estimates presented are for the downstream section only. Total harvest was expanded by 1,800 fish to account for harvest upstream of the survey area. Total effort was expanded by 55,741 angler hours to account for effort upstream of the survey area. Harvest expansion was based on an exploitation relationship for the years 1987-1994 from the SWHS. Effort expansion used the estimated harvest in the upstream area and assumed harvest per hour was similar to that in the downstream area.

recreational harvest and thus all samples were pooled. The majority (72%) of the harvest was of fish aged 1.4 (Table 5). Chinook salmon aged 1.4 were the predominant year class in the early-run harvest for all but one year since 1976 (Table 6).

Release mortality by age was estimated to more accurately estimate spawning escapement. During 1990, 1991, and 1992, nearly two-thirds of the catch was released (Table 7) due to emergency orders restricting the fishery to hook-and-release or trophy fishing. In 1996, approximately 39% of the catch was released resulting in an estimated mortality of 241 (SE = 136) chinook salmon (Table 7).

In 1996, a total harvest of 14 early-run chinook salmon was reported by the Kenaitze Indian Tribe. This compares to 73, 40, 2, 73, 118, 56 and 37 in 1989-1995, respectively. Additional chinook salmon were harvested in the personal use gillnet fishery in 1996; however, that information will not be available until all permits are returned and can be tabulated.

ESCAPEMENT AND TOTAL RETURN

Spawning escapement is the harvest plus hook-and-release mortality subtracted from the inriver return. In 1996, an estimated 17,298 (SE = 596) chinook salmon escaped all fisheries as potential spawners (Table 8). The majority of these spawners were age class

Table 5.-Estimates by age class of the number of early-run chinook salmon harvested in the recreational fishery on the downstream section of the Kenai River, 1996.

	Age Class					
	1.2	1.3	1.4	1.5	Other	Total
Males						
Sample Size	14	31	95	5	0	145
Percent	4.9	10.8	33.0	1.7	0.0	50.3
SE Percent	1.3	1.8	2.8	0.8	0.0	3.0
Harvest	203	448	1,374	72	0	2,097
SE Harvest	55	82	150	32	0	191
Females						
Sample Size	4	25	112	2	0	143
Percent	1.4	8.7	38.9	0.7	0.0	49.7
SE Percent	0.7	1.7	2.9	0.5	0.0	3.0
Harvest	58	362	1,620	29	0	2,069
SE Harvest	29	74	164	20	0	189
Combined						
Sample Size	18	56	207	7	0	288
Percent	6.3	19.4	71.9	2.4	0.0	100.0
SE Percent	1.4	2.3	2.7	0.9	0.0	
Harvest	260	810	2,994	101	0	4,166
SE Harvest	62	112	236	38	0	290

Table 6.-Estimates by age class of the number of early-run chinook salmon harvested in the recreational fishery on the Kenai River, 1976-1996.

	Age Class										
	1.1	1.2	1.3	1.4	1.5	1.6	2.3	2.4	2.5	Other	Total
1976											
Percent	3.9	26.4	24.0	42.2	2.4	0.0	1.0	0.0	0.0		100.0
Harvest	61	411	373	656	38	0	15	0	0		1,554
SE Harvest	21	48	47	54	17	0	11	0	0		NA
1977											
Percent	0.0	14.1	29.6	52.4	1.5	0.0	0.5	1.5	0.5		100.0
Harvest	0	306	643	1,138	32	0	11	32	11		2,173
SE Harvest	0	53	69	76	18	0	11	18	11		NA
1978											
Percent	0.0	16.0	18.9	65.2	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Harvest	0	246	291	1,005	0	0	0	0	0	0	1,542
SE Harvest	0	68	73	89	0	0	0	0	0	0	NA
1979											
Percent	5.8	30.8	51.9	11.5	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Harvest	154	819	1,381	307	0	0	0	0	0	0	2,661
SE Harvest	0	61	121	131	84	0	0	0	0	0	NA
1980											
Percent	0.0	9.0	14.9	69.8	6.3	0.0	0.0	0.0	0.0	0.0	100.0
Harvest	0	175	289	1,359	123	0	0	0	0	0	1,946
SE Harvest	0	37	47	60	32	0	0	0	0	0	NA
1981											
Percent		14.2	31.0	49.5	3.1					2.2	100.0
Harvest		641	1,402	2,242	140					100	4,525
SE Harvest		105	139	151	52					44	NA
1982											
Percent		6.3	23.3	62.3	4.4					3.8	100.0
Harvest		344	1,272	3,403	241					206	5,466
SE Harvest		106	184	211	89					83	NA
1983											
Percent		7.1	14.3	62.9	4.3					11.4	100.0
Harvest		454	909	3,998	273					726	6,360
SE Harvest		197	268	370	155					244	NA
1984											
Percent	0.0	3.4	27.8	61.8	6.9	0.0	0.0	0.0	0.0		100.0
Harvest	0	170	1,380	3,065	341	0	0	0	0		4,956
SE Harvest	0	53	130	141	74	0	0	0	0		NA
1985											
Percent	0.0	6.1	13.3	76.5	4.1	0.0	0.0	0.0	0.0		100.0
Harvest	0	488	1,058	6,100	325	0	0	0	0		7,971
SE Harvest	0	112	158	197	92	0	0	0	0		NA

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Table 6.-Page 2 of 3.

	Age Class										
	1.1	1.2	1.3	1.4	1.5	1.6	2.3	2.4	2.5	Other	Total
1986											
Percent	0.2	7.1	36.3	47.5	8.9	0.0	0.0	0.0	0.0		100.0
Harvest	14	540	2,741	3,591	675	0	0	0	0		7,561
SE Harvest	14	89	229	274	100	0	0	0	0		470
1987											
Percent	0.0	0.9	31.1	62.7	4.7	0.0	0.0	0.6	0.0		100.0
Harvest	0	113	4,134	8,326	623	0	0	85	0		13,281
SE Harvest	0	57	392	621	136	0	0	49	0		871
1988											
Percent	0.2	1.9	12.2	78.6	6.8	0.0	0.0	0.3	0.0		100.0
Harvest	22	244	1,555	10,016	866	0	0	44	0		12,747
SE Harvest	22	74	195	608	143	0	0	31	0		722
1989											
Percent	1.1	3.3	26.2	62.8	6.6	0.0	0.0	0.0	0.0		100.0
Harvest	79	238	1,903	4,560	476	0	0	0	0		7,256
SE Harvest	56	97	272	416	137	0	0	0	0		517
1990											
Percent	0.0	5.6	5.6	74.6	14.1	0.0	0.0	0.0	0.0		100.0
Harvest	0	98	98	1,295	244	0	0	0	0		1,735
SE Harvest	0	50	50	225	81	0	0	0	0		277
1991											
Percent	0.0	0.0	8.5	80.9	10.7	0.0	0.0	0.0	0.0		100.1
Harvest	0	0	76	720	95	0	0	0	0		891
SE Harvest	0	0	39	146	44	0	0	0	0		169
1992											
Percent	0.0	4.2	16.8	75.8	3.2	0.0	0.0	0.0	0.0		100.0
Harvest	0	58	229	1,035	43	0	0	0	0		1,365
SE Harvest	0	29	58	129	25	0	0	0	0		151
1993											
Percent	0.2	4.0	14.3	74.8	5.6	0.0	0.2	0.6	0.2		100.0
Harvest[a]	18	310	1,107	5,779	431	0	18	46	18		7,727
SE Harvest	16	60	118	319	75	0	16	24	16		383
1994											
Percent	0.0	5.2	9.4	82.9	2.6	0.0	0.0	0.0	0.0		100.0
Harvest[b]	0	292	528	4,670	144	0	0	0	0		5,634
SE Harvest	0	69	87	250	42	0	0	0	0		300

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Table 6.-Page 3 of 3.

	Age Class										
	1.1	1.2	1.3	1.4	1.5	1.6	2.3	2.4	2.5	Other	Total
1995											
Percent	0.0	8.4	12.6	70.8	8.2	0.0	0.0	0.0	0.0		100.0
Harvest[c]	0	872	1,298	7,313	844	0	0	0	0		10,327
SE Harvest	0	127	155	429	122	0	0	0	0		541
1996											
Percent	0.0	6.3	19.4	71.9	2.4	0.0	0.0	0.0	0.0		100.0
Harvest[d]	0	373	1,160	4,288	145	0	0	0	0		5,966
SE Harvest	0	89	163	355	55	0	0	0	0		442

[a] Includes 881 fish estimated harvested in unsurveyed areas of the Kenai River based on the mean proportion of harvest occurring in those areas during the years 1986-1989 when the areas were surveyed. Age composition in unsurveyed area assumed equal to the total age composition estimated for the harvest in the downstream section.

[b] Includes 912 fish estimated harvested in unsurveyed areas of the Kenai River based on the highest proportion of harvest occurring in those areas during the years 1986-1989 when the areas were surveyed. Age composition in unsurveyed area assumed equal to the total age composition estimated for the harvest in the downstream section.

[c] Includes an estimated 2,594 fish harvested in unsurveyed areas of the Kenai River. Harvest expansion was based on an exploitation relationship for the years 1987-1993 from the SWHS. Age composition in the unsurveyed area assumed equal to the age composition estimated for the harvest in the surveyed area.

[d] Includes an estimated 1,086 fish harvested in unsurveyed areas of the Kenai River. Harvest expansion was based on an exploitation relationship for the years 1987-1994 from the SWHS. Age composition in the unsurveyed area assumed equal to the age composition estimated for the harvest in the surveyed area.

Table 7.-Estimates of the number of early-run chinook salmon mortalities attributable to hook-and-release fishing, Kenai River, 1986-1996.

Year	Sport Catch	Sport Harvest	Number Released	SE Released	Percent Mortality[a]	SE Percent	Hook-and-Release Mortality	SE Mortality
1986	12,117	7,561	4,556	845	6.4 (E)	3.39	292	161
1987	19,119	13,281	5,838	1,492	6.4 (E)	3.39	374	214
1988	18,643	12,747	5,896	1,129	6.4 (E)	3.39	377	209
1989	9,901	7,256	2,645	831	6.4 (E)	3.39	169	100
1990	4,973	1,735	3,238	630	8.8 (M)	2.50	285	97
1991	3,716	891	2,825	391	4.1 (M)	1.98	116	58
1992	3,901	1,365	2,536	219	6.4 (E)	3.39	164	87
1993	11,153	7,727	3,454	523	6.4 (E)	3.39	219	120
1994	7,635	5,634	2,001	271	6.4 (E)	3.39	128	69
1995	16,600	10,327	6,273	832	6.4 (E)	3.39	401	217
1996	9,731	5,966	3,765	854	6.4 (E)	3.39	241	136

[a] (E) Estimated as the mean of the 1990 and 1991 mortality rates (Bendock and Alexandersdottir 1992).

(M) Measured.

Table 8.-Summary of early-run Kenai River chinook salmon population data, 1985-1996.

Year	Deep Creek Marine Harvest	Eastside Set Net Harvest	Drift Gill Net Harvest	Subsistence[a]	Inriver Return	Total Return	Kenai River Sport Harvest	Hook-and-Release Mortality	Spawning Escapement
1985	Unknown	Closed	Closed		15,972	15,972	7,971	Unknown	8,001
1986	Unknown	Closed	Closed		27,080	27,080	7,561	292	19,227
1987	Unknown	Closed	Closed		25,643	25,643	13,281	374	11,988
1988	Unknown	Closed	Closed		20,880	20,880	12,747	377	7,756
1989	Unknown	Closed	Closed	73	17,992	18,065	7,256	169	10,567
1990	Unknown	Closed	Closed	40	10,679	10,719	1,735	285	8,659
1991	Unknown	Closed	Closed	2	10,931	10,933	891	116	9,924
1992	Unknown	Closed	Closed	73	10,087	10,160	1,365	164	8,558
1993	Unknown	Closed	Closed	118	19,921	20,039	7,727	219	11,975
1994	Unknown	Closed	Closed	56	18,514	18,570	5,634	128	12,752
1995	Unknown	Closed	Closed	37	21,884	21,921	10,327	401	11,156
1996	Unknown	Closed	Closed	14	23,505	23,519	5,966	241	17,298

[a] Includes fish harvested in Kenaitze educational gillnet fishery and in the subsistence fishery.

1.4 (Table 9). This age class has been the predominant spawning age class since 1987.

BROOD RELATIONSHIPS

Returns at age were tabulated by sampling year (Table 10) and by brood year (Table 11). Total production from the first measured escapement (8,001 in 1985) was realized in 1993. Brood year 1988 (7,756 escapement) has shown the best total return of the measured escapements, 19,741 fish and 2.55 adults per spawner. The 1989 brood (10,567 escapement) has returned at 1.85 adults per spawner with one age class still to return. The 1990 brood (8,659 escapement) has the second best performance of the measured returns, at a return per spawner of 2.34 to 1, with two age classes still to return.

SIBLING RELATIONSHIPS

Using the sibling model of Sonnichsen and Alexandersdottir (1991) (Table 12), the forecast for the total return to the Kenai River during the 1997 early run is 31,622 (SE = 9,324) chinook salmon (Table 13).

MIGRATORY TIMING

In 1996, daily sonar counts of chinook salmon exceeded 150 from 20 May through 30 June. Daily counts exceeded 1,000 on 5 days, 4 June, 9 June, and 13-15 June. The largest count (1,140) occurred on 9 June (Table 1).

Daily projections of the inriver return remained within 20% of the final return from 31 May through 30 June (Figure 4). Cumulative proportions of the 1996 inriver return remained within the 95% confidence interval of the historical model (Figure 5) beginning May 16, except for 15 June-21 June and 25 June-27 June. The estimated total return throughout the season was large enough to preclude any restrictive management actions. On 9 June the bait restriction was removed.

DISCUSSION

Real-time estimates of the inriver return provided by the sonar project have greatly improved the department's ability to compensate for changing situations on relatively short notice. For example, data collected through the sonar project make it possible to implement trophy fishing, rather than a total fishery closure, in response to weak returns. Regulations can be liberalized in response to exceptionally strong returns. During 1990, 1991 and 1992, the spawning escapement goal for early-run chinook salmon was almost met due to inseason restrictions placed on the recreational fishery. In 1993, 1994, and 1996 regulations were liberalized to permit the use of bait in response to a relatively strong return without compromising the escapement goal.

The two closures adopted by the BOF for the 1993 season, one near the mouth of Slikok Creek and one near the mouth of the Funny River, both significant spawning streams for early-run fish, undoubtedly impacted the recreational fishery's overall harvest potential. These are primary holding areas for early-run chinook salmon in their migration routes and fish remain vulnerable to harvest for longer periods of time in these areas. Cursory staff observations during spawning indicated significant numbers of spawning chinook salmon in both streams.

Preseason forecasts for early-run chinook salmon to the Kenai River have been reported beginning with the 1990 return. The projected returns for the years 1990-1995 have ranged from 12,936 to 23,137 fish. The realized returns have ranged from 10,160 to 23,519 fish. Forecasts have been greater than the observed returns for 4 years and less for 3 years. Observed returns have ranged from

Table 9.-Estimates by age class of the number of early-run chinook salmon in the spawning escapement to the Kenai River, 1986-1996.

	Age Class										
	1.1	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	2.5	Total
1986											
Inriver Return[a]	0	4,554	11,731	8,880	1,908	0	0	0	7	0	27,080
SE Return	0	1,755	4,239	3,195	703	0	0	0	12	0	9,799
Harvest	14	540	2,741	3,591	675	0	0	0	0	0	7,561
SE Harvest	14	89	229	274	100	0	0	0	0	0	470
H&R[b] Mortality	0	45	121	102	24	0	0	0	0	0	292
SE H&R	0	23	49	40	9	0	0	0	0	0	161
Escapement[c]	0	3,969	8,869	5,187	1,209	0	0	0	7	0	19,227
SE Escapement	14	1,757	4,245	3,207	710	0	0	0	12	0	9,812
1987											
Inriver Return[a]	0	386	9,653	14,883	589	0	0	31	101	0	25,643
SE Return	0	125	2,080	3,732	226	0	0	31	56	0	5,928
Harvest	0	113	4,134	8,326	623	0	0	0	85	0	13,281
SE Harvest	0	57	392	621	136	0	0	0	49	0	871
H&R[b] Mortality	0	6	145	214	9	0	0	0	0	0	374
SE H&R	0	3	59	88	4	0	0	0	0	0	214
Escapement[c]	0	267	5,374	6,343	0	0	0	31	16	0	11,988
SE Escapement	0	137	2,117	3,784	264	0	0	31	74	0	5,995
1988											
Inriver Return[a]	0	358	3,088	15,077	2,279	57	0	21	0	0	20,880
SE Return	0	97	260	335	237	40	0	21	0	0	0
Harvest	22	244	1,555	10,016	866	0	0	44	0	0	12,747
SE Harvest	22	74	195	608	143	0	0	31	0	0	722
H&R[b] Mortality	0	7	59	268	41	0	0	2	0	0	377
SE H&R	0	23	49	40	9	0	0	0	0	0	209
Escapement[c]	0	107	1,474	4,793	1,372	57	0	0	0	0	7,756
SE Escapement	22	124	329	695	277	40	0	37	0	0	752
1989											
Inriver Return[a]	0	756	2,841	12,737	1,658	0	0	0	0	0	17,992
SE Return	0	137	250	311	195	0	0	0	0	0	0
Harvest	79	238	1903	4560	476	0	0	0	0	0	7,256
SE Harvest	56	97	272	416	137	0	0	0	0	0	517
H&R[b] Mortality	0	7	25	122	15	0	0	0	0	0	169
SE H&R	0	4	11	51	7	0	0	0	0	0	100
Escapement[c]	0	511	913	8,055	1,167	0	0	0	0	0	10,567
SE Escapement	56	168	370	522	238	0	0	0	0	0	527
1990											
Inriver Return[a]	0	792	2,794	6,460	633	0	0	0	0	0	10,679
SE Return	0	132	214	240	113	0	0	0	0	0	0
Harvest	0	98	98	1295	244	0	0	0	0	0	1,735
SE Harvest	0	50	50	225	81	0	0	0	0	0	277
H&R[b] Mortality	0	20	76	171	18	0	0	0	0	0	285
SE H&R	0	6	19	42	5	0	0	0	0	0	97
Escapement[c]	0	674	2,620	4,994	371	0	0	0	0	0	8,659
SE Escapement	0	141	221	332	139	0	0	0	0	0	293

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Table 9.-Page 2 of 3.

	Age Class										
	1.1	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	2.5	Total
1991											
Inriver Return[a]	0	801	2,449	7,116	565	0	0	0	0	0	10,931
SE Return	0	187	300	343	159	0	0	0	0	0	0
Harvest	0	0	76	720	95	0	0	0	0	0	891
SE Harvest	0	0	39	146	44	0	0	0	0	0	169
H&R[b] Mortality	0	8	26	76	6	0	0	0	0	0	116
SE H&R	0	5	10	28	3	0	0	0	0	0	58
Escapement[c]	0	793	2,347	6,320	464	0	0	0	0	0	9,924
SE Escapement	0	187	303	374	165	0	0	0	0	0	179
1992											
Inriver Return[a]	0	820	2,870	5,864	533	0	0	0	0	0	10,087
SE Return	0	176	291	318	144	0	0	0	0	0	0
Harvest	0	58	229	1035	43	0	0	0	0	0	1,365
SE Harvest	0	29	58	129	25	0	0	0	0	0	151
H&R[b] Mortality	0	13	47	95	9	0	0	0	0	0	164
SE H&R	0	7	25	51	4	0	0	0	0	0	87
Escapement[c]	0	749	2,594	4,734	481	0	0	0	0	0	8,558
SE Escapement	0	179	298	347	146	0	0	0	0	0	174
1993											
Inriver Return[a]	0	780	5,009	13,202	746	0	82	102	0	0	19,921
SE Return	0	231	501	552	228	0	82	58	0	0	0
Harvest	18	310	1,107	5,779	431	0	0	18	46	18	7,727
SE Harvest	0	29	58	129	25	0	0	16	24	16	383
H&R[b] Mortality	0	8	45	155	10	0	0	1	0	0	219
SE H&R	0	2	4	5	2	0	0	1	0	0	118
Escapement[c]	0	462	3,857	7,268	305	0	82	83	0	0	11,975
SE Escapement	0	233	504	567	229	0	82	60	24	16	401
1994											
Inriver Return[a]	0	660	3,664	12,719	809	0	44	121	386	0	18,403
SE Return	0	163	346	402	181	0	44	72	129	0	0
Harvest	0	279	517	4,691	147	0	0	0	0	0	5,634
SE Harvest	0	69	87	250	42	0	0	0	0	0	387
H&R[b] Mortality	0	4	23	92	6	0	0	1	2	0	128
SE H&R	0	2	8	31	3	0	0	1	2	0	43
Escapement[c]	0	377	3,124	7,936	656	0	44	120	384	0	12,641
SE Escapement	0	177	357	474	186	0	44	72	129	0	389
1995											
Inriver Return[a]	0	1,245	5,184	14,542	770	0	0	0	143	0	21,884
SE Return	0	387	694	759	261	0	0	0	143	0	0
Harvest	0	872	1,298	7,313	844	0	0	0	0	0	10,327
SE Harvest	0	127	155	429	122	0	0	0	0	0	541
H&R[b] Mortality	0	23	95	266	14	0	0	0	3	0	401
SE H&R	0	14	53	145	9	0	0	0	3	0	217
Escapement[c]	0	350	3,791	6,963	0	0	0	0	140	0	11,156
SE Escapement	0	408	713	884	288	0	0	0	143	0	583

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Table 9.-Page 3 of 3.

	Age Class										
	1.1	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	2.5	Total
1996											
Inriver Return[a]	0	1,846	6,746	14,415	497	0	0	0	0	0	23,505
SE Return	0	349	595	671	186	0	0	0	0	0	376
Harvest	0	373	1,160	4,288	145	0	0	0	0	0	5,966
SE Harvest	0	89	163	355	55	0	0	0	0	0	442
H&R[b] Mortality	0	19	69	148	5	0	0	0	0	0	241
SE H&R	0	11	39	83	3	0	0	0	0	0	136
Escapement[c]	0	1,454	5,517	9,979	347	0	0	0	0	0	17,298
SE Escapement	0	360	618	764	194	0	0	0	0	0	596

[a] Inriver return estimated from tag to untag ratio from 1986-1987; by sonar counter from 1988-1996.

[b] Hook-and-Release.

[c] For some age classes in some years the estimate of the number harvested in the sport fishery is greater than the estimate of the number in the inriver return. The spawning escapement for the age class was set to zero. When this occurred, the total spawning escapement (calculated by subtracting the total sport harvest plus the hook-and-release mortality from the inriver return) is not the sum of the escapement across age classes.

Table 10.-Age composition of measured returns of Kenai River early-run chinook salmon, 1986-1996.

Year	(0.2, 1.1) Age 3	(0.3, 1.2, 2.1) Age 4	(0.4, 1.3, 2.2) Age 5	(0.5, 1.4, 2.3) Age 6	(1.5, 2.4) Age 7	(1.6, 2.5) Age 8	Total Return
1986		4,554	11,731	8,880	1,915	0	27,080
1987		386	9,653	14,914	690	0	25,643
1988		358	3,088	15,098	2,279	57	20,880
1989		759	2,853	12,788	1,665	0	18,065
1990		793	2,796	6,487	643	0	10,719
1991		801	2,450	7,117	565	0	10,933
1992		826	2,891	5,906	537	0	10,160
1993		784	5,122	13,383	750	0	20,039
1994		662	3,719	12,880	1,198	0	18,459
1995		1,249	5,195	14,556	920	0	21,921
1996		1,847	6,750	14,424	497	0	23,519

Table 11.-Summary of returns from each brood year, early-run Kenai River chinook salmon, 1979-1996.

Year	Spawning Escapement	Return (0.3,1.2,2.1) Age 4	Return (0.4,1.3,2.2) Age 5	Return (0.5,1.4,2.3) Age 6	Return (1.5,2.4) Age 7	Return (1.6,2.5) Age 8	Measured Return To Date	Return Per Spawner
					(1986)			
1979	Unknown				1,915		1,915	
				(1986)	(1987)	(1988)		
1980	Unknown			8,880	690	57	9,627	
			(1986)	(1987)	(1988)			
1981	Unknown		11,731	14,914	2,279		28,924	
		(1986)	(1987)	(1988)	(1989)			
1982	Unknown	4,554	9,653	15,098	1,665		30,970	
		(1987)	(1988)	(1989)	(1990)			
1983	Unknown	386	3,088	12,788	643		16,905	
		(1988)	(1989)	(1990)	(1991)			
1984	Unknown	358	2,853	6,487	565		10,263	
		(1989)	(1990)	(1991)	(1992)			
1985	8,001	759	2,796	7,117	537		11,209	1.40
		(1990)	(1991)	(1992)	(1993)			
1986	19,227	793	2,450	5,906	750		9,899	0.51
		(1991)	(1992)	(1993)	(1994)			
1987	11,988	801	2,891	13,383	1,198		18,273	1.52
		(1992)	(1993)	(1994)	(1995)			
1988	7,756	826	5,122	12,880	920		19,748	2.55
		(1993)	(1994)	(1995)	(1996)			
1989	10,567	784	3,719	14,556	497		19,556	1.85
		(1994)	(1995)	(1996)				
1990	8,659	662	5,195	14,424			20,281	2.34
		(1995)	(1996)					
1991	9,924	1,249	6,750				7,999	0.81
		(1996)						
1992	8,558	1,847					1,847	0.22
1993	11,975							
1994	12,641							
1995	11,209							
1996	17,298							

Table 12.-Sibling return ratios from early-run Kenai River chinook salmon, brood years 1980-1991.

Brood Year	Age 5/ Age4	Age 6/ Age 5	Age 6/ Age4+5	Age 7/ Age 6	Age 7/ Age 5+6	Age 7/ Age4+5+6
1980				0.08		
1981		1.27		0.15	0.09	
1982	2.12	1.56	1.06	0.11	0.07	0.06
1983	8.00	4.14	3.68	0.05	0.04	0.04
1984	7.97	2.27	2.02	0.09	0.06	0.06
1985	3.68	2.55	2.00	0.08	0.05	0.05
1986	3.09	2.41	1.82	0.13	0.09	0.08
1987	3.61	4.63	3.62	0.09	0.07	0.07
1988	6.20	2.51	2.17	0.07	0.05	0.05
1989	4.74	3.92	3.23	0.03	0.03	0.03
1990	7.85	2.78	2.46			
1991	5.41					
Mean	5.27	2.80	2.45	0.09	0.06	0.05
Std. Dev.	2.17	1.10	0.89	0.04	0.02	0.02
% Coeff. Var.	41	39	36	40	34	32
Maximum	8.00	4.63	3.68	0.15	0.09	0.08
Minimum	2.12	1.27	1.06	0.03	0.03	0.03

Table 13.-Summary of expected returns based on sibling ratios versus observed returns, early-run Kenai River chinook salmon, 1990-1996, and 1997 projections. Numbers in parentheses denote negative numbers.

	Return				
	Age 4	Age 5	Age 6	Age 7	Total
1990					
Projected	1,514	4,576	7,616	1,213	14,919
Observed	775	2,851	6,409	684	10,719
Difference	(739)	(1,758)	(1,076)	(565)	(4,113)
% of Expected	51.2	62.3	84.2	56.4	71.8
1991					
Projected	1,371	4,363	8,085	471	14,290
Observed	801	2,450	7,117	565	10,933
Difference	(573)	(1,915)	(970)	97	(3,361)
% of Expected	58.4	56.2	88.0	120.0	76.5
1992					
Projected	1,276	3,983	7,126	551	12,936
Observed	826	2,891	5,906	537	10,160
Difference	(450)	(1,092)	(1,220)	(14)	(2,776)
% of Expected	64.7	72.6	82.9	97.5	78.5
1993					
Projected	1,208	3,939	7,785	474	13,406
Observed	784	5,122	13,383	750	20,039
Difference	(424)	1,183	5,598	276	6,633
% of Expected	64.9	130.0	171.9	158.2	149.5
1994					
Projected	1,158	3,883	14,089	980	20,110
Observed	662	3,719	12,880	1,198	18,459
Difference	(496)	(164)	(1,209)	218	(1,651)
% of Expected	57.2	95.8	91.4	122.2	91.8
1995					
Projection	1,103	3,262	10,535	1,120	16,020
Observed	1,251	5,209	14,599	916	21,975
Difference	148	1,947	4,064	(204)	5,955
% of Expected	113.4	159.7	138.6	81.8	137.2
1996					
Projection	1,117	6,559	14,357	1,105	23,138
Observed	1,847	6,750	14,424	497	23,518
Difference	730	191	67	(608)	380
% of Expected	165.4	102.9	100.5	45.0	101.6
1997					
Projection	1,183	9,729	19,616	1,094	31,622
Standard Error	1,190	5,277	7,580	465	9,324

71.8% to 149.5% of the expected return with the 1995 forecast being the closest to the realized return (101.7%). Although the fishery is managed based on the inseason return, the forecasts have been beneficial in preparing the fishing public, in a general sense, for the type of fishery to expect. Returns during recent years in the magnitude of 10,000 to 11,000 fish (1990-1992) required inseason restrictions to achieve the desired escapement. Returns in the magnitude of 18,000 to 20,000 fish (1993-1996) allowed for the fishery to be liberalized and still exceed the escapement goal. The anticipated return of about 31,600 fish in 1997 would allow for a harvest of 22,000 fish. Should the forecast be realized and normal timing occur, no inseason restrictions should be required.

Questions raised in 1995 regarding the ability of the sonar counter to accurately assess the inriver migration during periods of high sockeye salmon *O. nerka* abundance present more of a concern during the late run and should not compromise the department's ability to manage for sustained yield of the early run.

The largest potential problem in the stock assessment program is the inability to estimate harvest of early-run Kenai River chinook salmon in the marine fishery. Although not believed to be a problem to date, this fishery is growing and harvest of Kenai River chinook salmon could become significant.

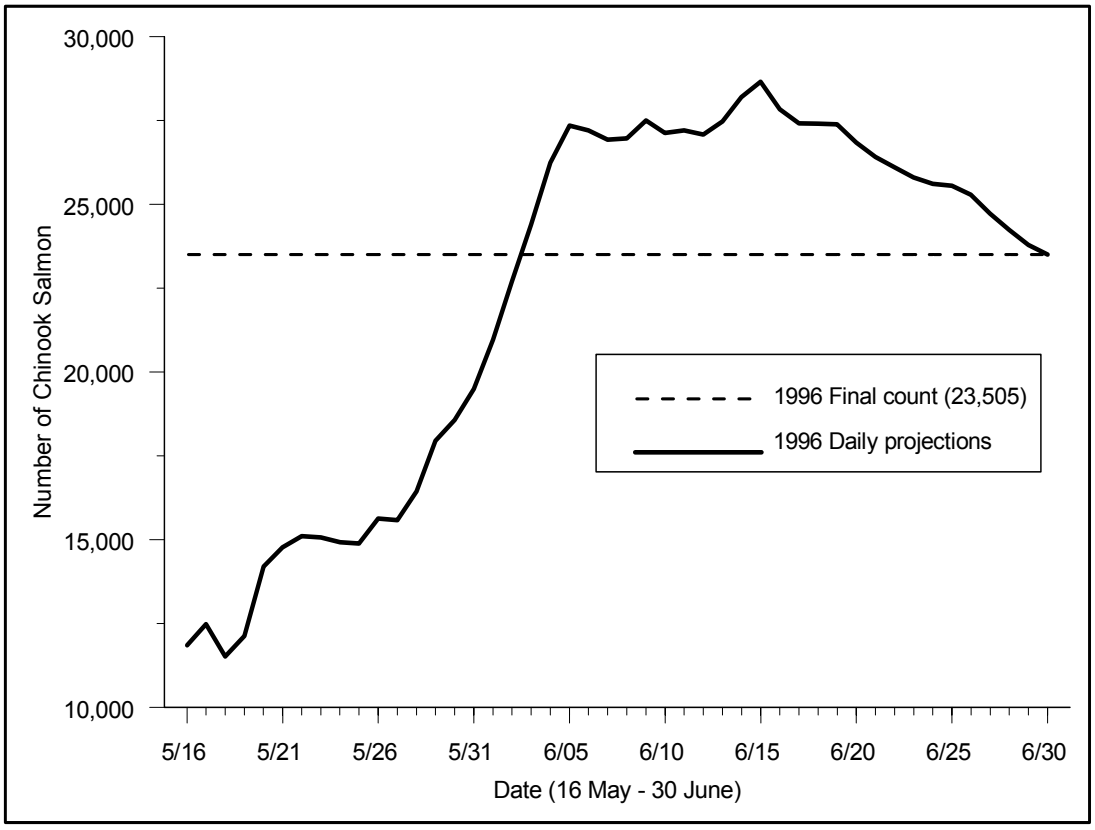

Figure 4.-Daily projections of total inriver return vs. the actual inriver return of early-run chinook salmon, 1996.

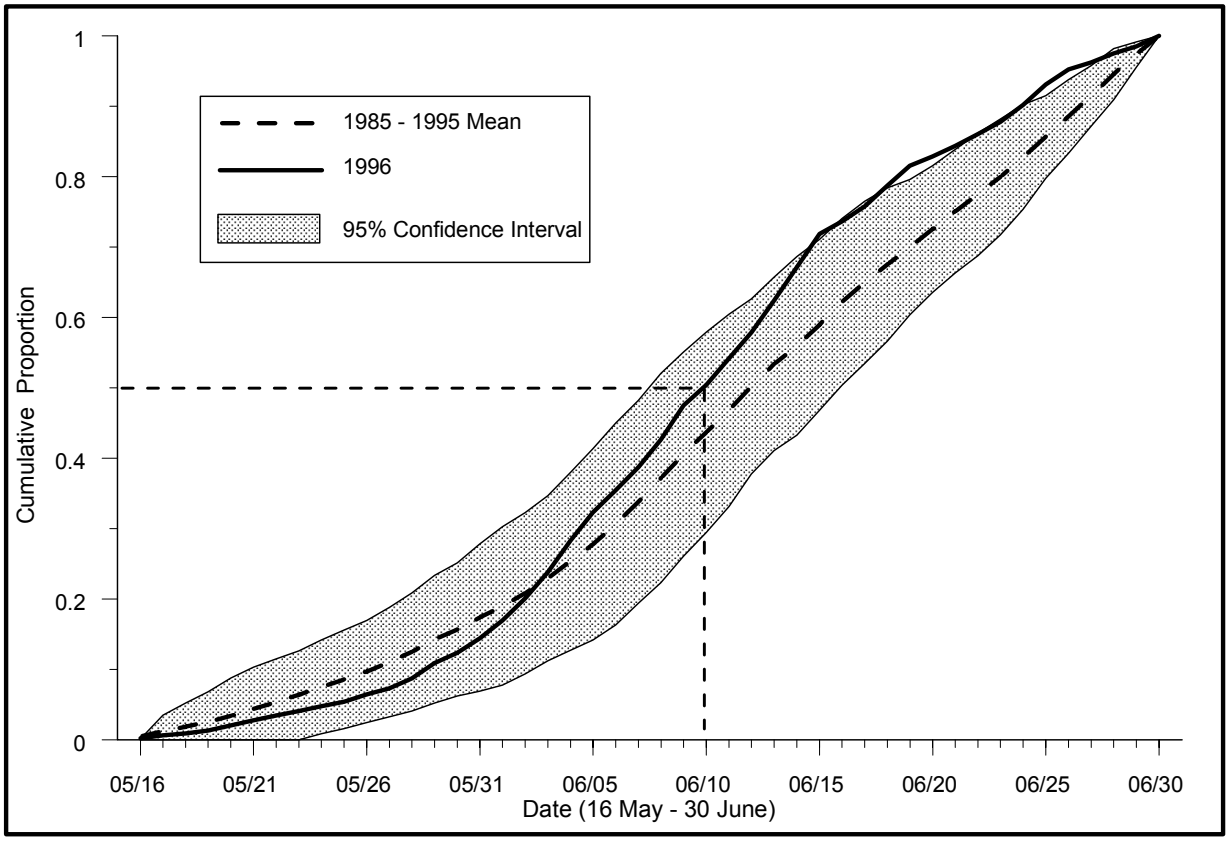

Figure 5.-Cumulative proportions by date for the inriver return of early-run chinook salmon to the Kenai River, 1985-1995 mean vs. 1996.

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APPENDIX A. STATISTICAL METHODS

Appendix A1.-Statistical methods for estimating sibling ratios and expected returns.

The following methods for estimating sibling ratios and expected returns were modified from Sonnichsen and Alexandersdottir 1991.

Age structure is a conservative trait in salmonids, the age classes represented within brood years in a stock do not change drastically across years. The distribution of numbers returning in each age class within a brood year may also be a stable character within a stock. The relationships between ages within a brood year, or sibling relationships, were used to estimate future returns by brood year.

Sibling ratios, r_{ab}, were estimated as the ratio of the return at age a to the total return at one or more younger ages for each brood year b:

$$\hat{r}_{ab} = \frac{\hat{n}_{ab}}{\hat{n}_{a'b}}, \tag{A1.1}$$

where $\hat{n}_{ab}$ is the estimated number of fish from brood year b returning at age a and $\hat{n}_{a'b}$ is the estimated number from brood year b returning at ages 4 through "a - 1":

$$\hat{n}_{a'b} = \sum_{j=4}^{a-1} \hat{n}_{jb}. \tag{A1.2}$$

Age 4 is the first year at which early-run Kenai River chinook salmon return in substantial numbers. Sibling ratios were estimated for ages 5 through 7. The variances of the estimated sibling ratios were estimated as:

$$\hat{V}[\hat{r}_{ab}] = \hat{r}_{ab}^2 \left(\frac{\hat{V}[\hat{n}_{ab}]}{\hat{n}_{ab}^2} + \frac{\hat{V}[\hat{n}_{a'b}]}{\hat{n}_{a'b}^2} \right), \tag{A1.3}$$

where:

$$\hat{V}[\hat{n}_{a'b}] = \sum_{j=4}^{a-1} \hat{V}[\hat{n}_{jb}]. \tag{A1.4}$$

The expected returns of fish aged a = 5, 6, and 7 in the year (Y) to be forecasted are:

$$\tilde{n}_a = \bar{r}_a \hat{n}_{a'b}, \tag{A1.5}$$

where $\bar{r}_a$ is the mean age-a sibling ratio, averaged over all m_a brood years for which the ratio could be estimated:

$$\bar{r}_a = \frac{1}{m_a} \sum_{b=1}^{m_a} \hat{r}_{ab}, \tag{A1.6}$$

and where b = Y - a.

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The variance of the forecasted returns by age was estimated as:

$$\hat{V}[\tilde{n}_a] = \bar{r}_a^2 \hat{V}[\hat{n}_{a'b}] + \hat{n}_{a'b}^2 \hat{V}'[\bar{r}_a] - \hat{V}'[\bar{r}_a]\hat{V}[\hat{n}_{a'b}] \quad \text{(A1.7)}$$

where $\hat{V}'[\bar{r}_a]$ is the squared prediction error of $\bar{r}_a$:

$$\hat{V}'[\bar{r}_a] = \frac{\sum_{b=1}^{m_a}(\hat{r}_{ab} - \bar{r}_a)^2}{m_a - 1} + \frac{\sum_{b=1}^{m_a}\hat{V}[\hat{r}_{ab}]}{m_a}. \quad \text{(A1.8)}$$

The expected return of age-4 fish in 1996 was forecast to be the mean of past age-4 returns:

$$\tilde{n}_4 = \frac{\sum_{b=1}^{m_a}\hat{n}_{4b}}{m_a}. \quad \text{(A1.9)}$$

The variance of the forecasted return of age-4 fish was estimated as the sample variance:

$$\hat{V}[\tilde{n}_4] = \frac{\sum_{b=1}^{m_a}(\hat{n}_{4b} - \tilde{n}_4)^2}{m_a - 1}. \quad \text{(A1.10)}$$

Total return was forecast to be:

$$\tilde{n} = \sum_{a=4}^{7}\tilde{n}_a, \quad \text{(A1.11)}$$

with variance:

$$\hat{V}[\tilde{n}] = \sum_{a=4}^{7}\hat{V}[\tilde{n}_a]. \quad \text{(A1.12)}$$

Appendix A2.-Statistical methods for analyzing migratory timing.

The following methods for analyzing migratory timing were modified from McBride et al. 1989.

The distribution over time of salmon migrating past any fixed location can be described by a migratory time distribution function (Mundy 1982). We used historical databases of sonar counts, sport fishing effort, harvest per hour, catch per hour, harvest, and catch to predict final estimates of these parameters inseason. Our databases consisted of values, for example counts or harvests of chinook salmon, by day (t). Daily cumulative proportions were calculated for each year (i) of data and for each parameter. Daily values were summed to calculate a total (N_i) for the year. For each day t and year i, the cumulative proportion p_{ti} was calculated as:

$$p_{ti} = n_{ti} / N_i \ , \tag{A2.1}$$

where n_{ti} is the cumulative sum to date. For each year i, the set P_i of all cumulative proportions (p_{1i}, p_{2i}, p_{3i}, . . .) represents the annual empirical cumulative distribution function (CDF). The mid-point of the migration, or median of the distribution, is reached when p_{ti} is equal to 0.5.

For any day the mean cumulative proportion ($\bar{p}_{t\cdot}$) over all m years was calculated as:

$$\bar{p}_{t\cdot} = \frac{1}{m}\sum_{i=1}^{m} p_{ti} \ ; \tag{A2.2}$$

with variance:

$$\hat{V}[\bar{p}_{t\cdot}] = \frac{1}{m-1}\sum_{i=1}^{m}(p_{ti} - \bar{p}_{t\cdot})^2 \ . \tag{A2.3}$$

At any point in a migration, the mean cumulative proportion to date can be used to forecast the total given the number known to have passed to date. Since n_{tj} represents the number passed by day t in year j, then the predicted total for that year is:

$$\tilde{N}_j = \frac{n_{tj}}{\bar{p}_{t\cdot}}, \tag{A2.4}$$

and the variance of $\tilde{N}_j$ by:

$$\hat{V}[\tilde{N}_j] = \tilde{N}_j^2\left[\frac{\hat{V}[n_{tj}]}{n_{tj}^2} + \frac{\hat{V}[\bar{p}_{t\cdot}]}{\bar{p}_{t\cdot}^2}\right]. \tag{A2.5}$$

Appendix A3.-Statistical methods for estimating harvest upstream of the Soldotna Bridge.

During the early run, anglers caught and harvested chinook salmon between the Soldotna Bridge and Skilak Lake. To estimate harvest and catch upstream of the Soldotna Bridge inseason required exploring a potential relationship between exploitation rate during the early run, estimated using harvest data from the creel survey project and inriver return data from the sonar project, and harvest and catch estimates from the SWHS. To explore these relationships we used creel survey, sonar, and SWHS estimates from 1987-1994 (Hammarstrom 1995, Mills 1988-1994, Howe et. al. 1995). Because the SWHS presents estimates of both runs combined, we assumed 50% of the harvest and catch between the Soldotna Bridge and the confluence with the Moose River were fish from the early run and 100% of the harvest and catch upstream of the confluence with the Moose River were fish from the early run.

There was a significant ($F = 37.80$; $df = 1, 6$; $P = 0.001$) linear relationship between exploitation rate and harvest upstream of the Soldotna Bridge to the confluence of the Moose River. Total harvest between the Soldotna Bridge and Moose River was estimated by:

$$\hat{H}_m = 472 + 3{,}663\left(\hat{X}_z\right), \tag{A3.1}$$

and its variance was estimated by (Neter et al. 1990):

$$V\left(\hat{H}_m\right) = MSE\left[\frac{1}{Y} + \frac{\left(\hat{X}_z - \overline{X}\right)^2}{\sum_{y=1}^{Y}\left(\hat{X}_y - \overline{X}\right)^2}\right], \tag{A3.2}$$

where:

$\hat{H}_m$ = predicted total harvest between the Soldotna Bridge and Moose River,

$\hat{X}_z$ = exploitation rate of chinook salmon downstream of the Soldotna Bridge during the most recent year z,

= $\frac{\hat{H}_z}{\hat{I}_z}$,

$\hat{H}_z$ = total harvest downstream of the Soldotna Bridge during the most recent year z,

$\hat{I}_z$ = total inriver return during the most recent year z estimated from the sonar,

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MSE = mean square error of the historic data used to develop the relationship,

Y = number of years of historic data used to develop the relationship,

$\hat{X}_y$ = exploitation rate of year y used to develop the relationship, and

$\overline{X}$ = average exploitation rate over all years Y used to develop the relationship.

This is a minimum estimate of variance because it treats exploitation rate as a quantity measured without error.

The estimated 1996 harvest in the area between the Soldotna Bridge and Moose River was 1,121 (SE = 118).

Although a linear relationship ($F = 5.82$; $df = 1, 6$; $P = 0.05$) existed between exploitation rate and harvest upstream of the Moose River, a plot of the data indicated that a few data points had a large influence on this result. A relatively low R^2 value (=0.41), and pattern and size of some of the residuals indicated this model may be a poor predictive tool. In addition, there was no difference in harvest ($|t| = 2.10$, $df = 6$, $P = 0.08$) between years when exploitation was ≤ 0.15 and years when exploitation was > 0.25. Therefore, the estimated harvest upstream of the Moose River in 1996 was the average harvest from the SWHS since 1987, or 679 fish [V(H) = 97,415].

There was also no relationship ($P \geq 0.09$) between exploitation rate and catch for either section upstream of the Soldotna Bridge; however, there are only 5 years of catch estimates from the SWHS and during 3 of those years exploitation during the early run was < 0.15. Catch between the Soldotna Bridge and Moose River differed ($|t| = 4.16$, $df = 3$, $P = 0.03$) between years when exploitation was < 0.15 and years when exploitation was > 0.25. Because the exploitation rate of the early run in 1996 was > 0.15, the catch of 2,605 fish [V(C) = 1,352] was estimated from the mean of the estimates of catch from the SWHS from years when exploitation was > 0.15. Catch upstream of the Moose River was estimated similar to harvest in this stretch of the river: estimated catch in 1996 was the average from the SWHS, or 1,574 [V(C) =430,508].

The estimates of total harvest and catch, and their respective variances, were the sum of the respective statistics from the three sections of the Kenai River (i.e., downstream of the Soldotna Bridge from the creel survey data, and upstream of the Soldotna Bridge to the confluence of the Moose River and upstream of the Moose River to Skilak Lake using the approaches described above).

APPENDIX B. SUPPORTING STATISTICS

Appendix B1.-Historical daily cumulative proportions of the inriver return of early-run chinook salmon to the Kenai River, 1985-1996.

	Daily cumulative proportions [P(t)] by year of inriver return											1985-1995		95% Confidence Interval		Rel[a]	
Date	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Mean	SE	Low	High	Prec	1996
5/16	0.000	0.000	0.000	0.009	0.010	0.007	0.003	0.005	0.004	0.013	0.004	0.005	0.001	0.002	0.008	56.9%	0.003
5/17	0.000	0.001	0.000	0.029	0.028	0.013	0.004	0.010	0.009	0.032	0.009	0.012	0.004	0.004	0.020	65.9%	0.006
5/18	0.000	0.001	0.000	0.041	0.042	0.021	0.010	0.019	0.012	0.046	0.013	0.019	0.005	0.007	0.030	62.3%	0.009
5/19	0.000	0.007	0.000	0.054	0.052	0.034	0.015	0.023	0.016	0.062	0.019	0.026	0.007	0.011	0.040	57.6%	0.013
5/20	0.000	0.009	0.005	0.073	0.061	0.043	0.021	0.031	0.024	0.082	0.030	0.034	0.008	0.016	0.053	53.7%	0.021
5/21	0.009	0.011	0.015	0.082	0.074	0.049	0.026	0.039	0.030	0.100	0.051	0.044	0.009	0.024	0.065	46.3%	0.028
5/22	0.019	0.013	0.027	0.091	0.083	0.056	0.036	0.050	0.038	0.113	0.063	0.054	0.010	0.032	0.075	39.7%	0.034
5/23	0.036	0.023	0.038	0.102	0.094	0.062	0.042	0.065	0.045	0.124	0.076	0.064	0.010	0.043	0.085	33.1%	0.041
5/24	0.047	0.041	0.044	0.116	0.109	0.067	0.048	0.078	0.052	0.141	0.088	0.076	0.010	0.053	0.098	30.3%	0.048
5/25	0.067	0.056	0.044	0.132	0.126	0.074	0.053	0.085	0.061	0.150	0.097	0.086	0.011	0.062	0.110	28.0%	0.054
5/26	0.086	0.068	0.056	0.151	0.141	0.081	0.061	0.095	0.068	0.159	0.106	0.097	0.011	0.072	0.122	25.7%	0.065
5/27	0.104	0.079	0.072	0.170	0.164	0.089	0.068	0.101	0.084	0.173	0.114	0.111	0.012	0.084	0.137	24.2%	0.073
~~5/28~~	~~0.124~~	~~0.089~~	~~0.090~~	~~0.193~~	~~0.184~~	~~0.094~~	~~0.075~~	~~0.109~~	~~0.109~~	~~0.187~~	~~0.121~~	~~0.125~~	~~0.013~~	~~0.096~~	~~0.154~~	~~23.1%~~	~~0.087~~
5/29	0.136	0.116	0.132	0.227	0.199	0.108	0.080	0.113	0.126	0.206	0.131	0.143	0.014	0.112	0.174	21.8%	0.109
5/30	0.153	0.125	0.159	0.243	0.208	0.121	0.084	0.124	0.139	0.223	0.147	0.157	0.015	0.124	0.190	20.7%	0.124
5/31	0.159	0.142	0.213	0.267	0.217	0.137	0.091	0.136	0.148	0.243	0.160	0.174	0.016	0.138	0.210	20.7%	0.144
6/01	0.167	0.155	0.242	0.294	0.231	0.151	0.104	0.146	0.168	0.261	0.176	0.191	0.017	0.152	0.229	20.4%	0.170
6/02	0.178	0.173	0.265	0.320	0.242	0.180	0.126	0.157	0.184	0.275	0.193	0.208	0.018	0.169	0.248	18.9%	0.201
6/03	0.201	0.178	0.298	0.348	0.255	0.202	0.160	0.180	0.197	0.292	0.218	0.230	0.018	0.189	0.270	17.6%	0.238
6/04	0.237	0.205	0.335	0.384	0.269	0.218	0.176	0.199	0.211	0.308	0.250	0.254	0.019	0.210	0.297	17.1%	0.283
6/05	0.274	0.227	0.371	0.422	0.284	0.236	0.205	0.215	0.227	0.327	0.269	0.278	0.021	0.231	0.325	16.8%	0.323
6/06	0.318	0.267	0.427	0.446	0.305	0.251	0.231	0.247	0.237	0.338	0.306	0.307	0.022	0.257	0.356	16.0%	0.355
6/07	0.359	0.314	0.461	0.470	0.336	0.279	0.251	0.298	0.252	0.359	0.345	0.338	0.022	0.289	0.388	14.6%	0.388
6/08	0.402	0.349	0.487	0.507	0.385	0.318	0.273	0.335	0.271	0.375	0.390	0.372	0.023	0.321	0.423	13.7%	0.427
6/09	0.444	0.382	0.507	0.534	0.436	0.349	0.314	0.383	0.294	0.401	0.427	0.406	0.022	0.357	0.456	12.2%	0.475
6/10	0.481	0.434	0.521	0.550	0.487	0.374	0.340	0.409	0.321	0.424	0.467	0.437	0.022	0.388	0.486	11.2%	0.504
6/11	0.513	0.490	0.536	0.565	0.526	0.417	0.370	0.432	0.352	0.447	0.502	0.468	0.021	0.421	0.515	10.0%	0.542
6/12	0.552	0.545	0.558	0.580	0.558	0.470	0.406	0.471	0.399	0.465	0.521	0.502	0.019	0.460	0.545	8.5%	0.579
6/13	0.591	0.594	0.596	0.589	0.591	0.512	0.439	0.495	0.440	0.485	0.543	0.534	0.019	0.492	0.576	7.9%	0.624
6/14	0.611	0.629	0.631	0.603	0.617	0.543	0.464	0.512	0.460	0.513	0.575	0.560	0.019	0.516	0.603	7.7%	0.671

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Appendix B1.-Page 2 of 2.

Date	Daily cumulative proportions [P(t)] by year of inriver return											1985-1995		95% Confidence Interval		Rel[a]	
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Mean	SE	Low	High	Prec	1996
6/15	0.633	0.656	0.660	0.627	0.636	0.604	0.503	0.543	0.491	0.530	0.604	0.590	0.019	0.548	0.631	7.0%	0.719
6/16	0.666	0.682	0.690	0.666	0.658	0.649	0.559	0.567	0.520	0.554	0.634	0.622	0.018	0.582	0.663	6.5%	0.737
6/17	0.694	0.703	0.714	0.691	0.686	0.675	0.590	0.600	0.550	0.572	0.668	0.649	0.018	0.610	0.689	6.1%	0.758
6/18	0.716	0.717	0.728	0.717	0.712	0.697	0.635	0.632	0.572	0.595	0.705	0.675	0.017	0.637	0.713	5.6%	0.787
6/19	0.744	0.735	0.736	0.726	0.728	0.728	0.675	0.671	0.597	0.630	0.724	0.700	0.015	0.666	0.733	4.7%	0.815
6/20	0.764	0.745	0.758	0.735	0.756	0.763	0.704	0.725	0.628	0.652	0.751	0.726	0.014	0.695	0.757	4.3%	0.829
6/21	0.786	0.759	0.778	0.753	0.785	0.787	0.746	0.762	0.648	0.683	0.771	0.751	0.014	0.720	0.781	4.0%	0.844
6/22	0.811	0.775	0.791	0.768	0.819	0.812	0.786	0.791	0.679	0.702	0.788	0.775	0.014	0.745	0.805	3.9%	0.861
6/23	0.839	0.798	0.809	0.786	0.849	0.834	0.822	0.813	0.715	0.732	0.796	0.799	0.013	0.771	0.828	3.6%	0.878
6/24	0.857	0.818	0.833	0.818	0.881	0.864	0.845	0.846	0.755	0.770	0.817	0.828	0.012	0.802	0.853	3.1%	0.902
6/25	0.872	0.852	0.859	0.846	0.902	0.889	0.866	0.882	0.808	0.810	0.837	0.856	0.009	0.836	0.877	2.4%	0.931
6/26	0.887	0.881	0.898	0.867	0.922	0.919	0.890	0.915	0.866	0.843	0.852	0.885	0.008	0.868	0.903	2.0%	0.953
6/27	0.899	0.921	0.925	0.893	0.939	0.940	0.922	0.943	0.906	0.877	0.895	0.915	0.007	0.900	0.929	1.6%	0.962
6/28	0.924	0.963	0.952	0.932	0.963	0.962	0.952	0.968	0.943	0.914	0.927	0.946	0.006	0.933	0.958	1.3%	0.975
6/29	0.962	0.983	0.973	0.956	0.984	0.982	0.975	0.980	0.976	0.965	0.972	0.973	0.003	0.967	0.980	0.6%	0.985
6/30	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%	1.000

[a] Relative precision.

Appendix B2.-Historical daily cumulative proportions of the effort by unguided anglers during the return of early-run chinook salmon to the Kenai River, 1986-1996.

	Daily cumulative proportions [P(t)] by year of unguided angler effort											1986-1996		95% Confidence Interval		Rel[a]
Date	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Mean	SE	Low	High	Prec
5/16	0.000	0.005	0.000	0.003	0.006	0.006	0.004	0.000	0.000	0.000	0.000	0.002	0.001	0.000	0.004	80.1%
5/17	0.005	0.011	0.005	0.006	0.011	0.011	0.008	0.000	0.000	0.005	0.003	0.006	0.001	0.003	0.009	47.1%
5/18	0.010	0.011	0.009	0.010	0.018	0.017	0.008	0.000	0.000	0.011	0.005	0.009	0.002	0.005	0.013	42.3%
5/19	0.010	0.016	0.014	0.015	0.052	0.022	0.011	0.000	0.021	0.032	0.016	0.019	0.004	0.010	0.028	47.8%
5/20	0.015	0.019	0.027	0.034	0.075	0.022	0.016	0.000	0.027	0.047	0.041	0.029	0.006	0.016	0.043	45.3%
5/21	0.020	0.024	0.064	0.041	0.075	0.028	0.020	0.000	0.052	0.073	0.058	0.041	0.007	0.025	0.058	40.1%
5/22	0.023	0.029	0.089	0.041	0.087	0.034	0.024	0.007	0.057	0.073	0.058	0.047	0.008	0.029	0.066	38.8%
5/23	0.027	0.055	0.089	0.048	0.103	0.039	0.054	0.018	0.057	0.082	0.066	0.058	0.008	0.041	0.075	29.9%
5/24	0.042	0.080	0.100	0.054	0.119	0.061	0.158	0.018	0.069	0.100	0.069	0.079	0.012	0.053	0.105	32.8%
5/25	0.072	0.087	0.108	0.058	0.141	0.068	0.204	0.023	0.078	0.123	0.077	0.094	0.015	0.062	0.127	34.4%
5/26	0.083	0.095	0.115	0.067	0.231	0.136	0.212	0.029	0.086	0.135	0.087	0.116	0.018	0.075	0.157	35.0%
5/27	0.084	0.101	0.130	0.104	0.318	0.149	0.229	0.041	0.099	0.168	0.127	0.141	0.023	0.090	0.192	36.3%
5/28	0.085	0.109	0.150	0.158	0.371	0.156	0.251	0.057	0.135	0.193	0.169	0.167	0.026	0.109	0.224	34.4%
5/29	0.089	0.118	0.207	0.175	0.388	0.166	0.259	0.086	0.183	0.200	0.190	0.187	0.026	0.131	0.244	30.3%
5/30	0.094	0.180	0.222	0.183	0.413	0.178	0.308	0.134	0.222	0.216	0.204	0.214	0.026	0.157	0.271	26.8%
5/31	0.110	0.218	0.247	0.192	0.432	0.192	0.372	0.159	0.234	0.233	0.214	0.237	0.028	0.175	0.298	26.0%
6/01	0.121	0.218	0.267	0.200	0.453	0.246	0.372	0.168	0.253	0.251	0.226	0.252	0.028	0.191	0.314	24.4%
6/02	0.121	0.238	0.304	0.209	0.506	0.297	0.414	0.177	0.272	0.271	0.244	0.277	0.032	0.206	0.349	25.8%
6/03	0.129	0.259	0.329	0.276	0.584	0.297	0.438	0.195	0.285	0.295	0.279	0.306	0.036	0.226	0.387	26.3%
6/04	0.140	0.279	0.416	0.309	0.584	0.324	0.468	0.216	0.336	0.314	0.305	0.336	0.036	0.255	0.416	24.0%
6/05	0.157	0.310	0.433	0.309	0.617	0.401	0.498	0.275	0.375	0.314	0.305	0.363	0.037	0.281	0.446	22.7%
6/06	0.177	0.396	0.433	0.332	0.655	0.404	0.586	0.308	0.375	0.344	0.324	0.394	0.040	0.306	0.482	22.4%
6/07	0.267	0.438	0.466	0.360	0.656	0.416	0.628	0.308	0.403	0.373	0.331	0.422	0.037	0.340	0.505	19.6%
6/08	0.325	0.438	0.486	0.387	0.664	0.437	0.628	0.327	0.425	0.398	0.350	0.442	0.034	0.367	0.518	17.1%
6/09	0.325	0.474	0.496	0.421	0.686	0.452	0.676	0.345	0.447	0.441	0.376	0.467	0.036	0.388	0.546	17.0%
6/10	0.358	0.502	0.509	0.471	0.694	0.452	0.685	0.366	0.475	0.475	0.441	0.494	0.033	0.421	0.566	14.8%
6/11	0.386	0.530	0.569	0.510	0.694	0.465	0.695	0.396	0.518	0.491	0.490	0.522	0.030	0.454	0.590	13.0%
6/12	0.415	0.564	0.593	0.510	0.703	0.485	0.710	0.458	0.556	0.491	0.490	0.543	0.029	0.479	0.607	11.8%
6/13	0.487	0.630	0.593	0.537	0.705	0.495	0.737	0.510	0.556	0.527	0.518	0.572	0.026	0.515	0.629	10.0%
6/14	0.566	0.658	0.625	0.551	0.714	0.510	0.760	0.510	0.586	0.541	0.529	0.596	0.025	0.539	0.652	9.5%

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Appendix B2.-Page 2 of 2.

	Daily cumulative proportions [P(t)] by year of unguided angler effort											1986-1996		95% Confidence Interval		Rel[a]
Date	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Mean	SE	Low	High	Prec
6/15	0.640	0.658	0.648	0.575	0.727	0.524	0.760	0.556	0.598	0.567	0.536	0.617	0.023	0.566	0.669	8.4%
6/16	0.640	0.674	0.678	0.598	0.746	0.553	0.782	0.567	0.624	0.595	0.552	0.637	0.023	0.586	0.688	8.1%
6/17	0.677	0.702	0.707	0.642	0.766	0.553	0.794	0.591	0.650	0.622	0.610	0.665	0.022	0.616	0.714	7.4%
6/18	0.699	0.726	0.741	0.668	0.766	0.569	0.806	0.614	0.687	0.650	0.662	0.690	0.021	0.644	0.736	6.6%
6/19	0.720	0.749	0.763	0.668	0.785	0.577	0.824	0.681	0.701	0.650	0.662	0.707	0.021	0.660	0.754	6.7%
6/20	0.746	0.798	0.763	0.694	0.800	0.602	0.861	0.718	0.701	0.683	0.706	0.734	0.021	0.687	0.781	6.4%
6/21	0.791	0.834	0.790	0.726	0.813	0.617	0.876	0.718	0.726	0.714	0.731	0.758	0.022	0.710	0.806	6.3%
6/22	0.815	0.834	0.812	0.750	0.829	0.675	0.876	0.749	0.741	0.747	0.768	0.781	0.017	0.743	0.820	4.9%
6/23	0.815	0.847	0.832	0.779	0.869	0.697	0.898	0.771	0.757	0.776	0.787	0.802	0.017	0.764	0.841	4.8%
6/24	0.833	0.864	0.849	0.827	0.907	0.697	0.909	0.794	0.779	0.802	0.828	0.826	0.018	0.786	0.867	4.9%
6/25	0.858	0.888	0.898	0.883	0.907	0.707	0.922	0.810	0.808	0.828	0.862	0.852	0.019	0.811	0.893	4.8%
6/26	0.888	0.920	0.931	0.883	0.925	0.722	0.932	0.863	0.891	0.828	0.862	0.877	0.018	0.836	0.918	4.7%
6/27	0.913	0.943	0.931	0.923	0.943	0.736	0.950	0.929	0.891	0.877	0.899	0.903	0.018	0.863	0.944	4.5%
6/28	0.960	0.980	0.959	0.953	0.956	0.811	0.984	0.929	0.927	0.923	0.939	0.938	0.014	0.907	0.970	3.4%
6/29	1.000	0.980	0.984	0.980	0.972	0.918	0.984	0.975	0.973	0.964	0.975	0.973	0.006	0.960	0.987	1.4%
6/30	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%

[a] Relative precision.

Appendix B3.-Historical daily cumulative proportions of the harvest of chinook salmon by unguided anglers during the return of early-run chinook salmon to the Kenai River, 1986-1996.

	Daily cumulative proportions [P(t)] by year of harvest by unguided anglers											1986-1996		95% Confidence Interval		Rel[a]
Date	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Mean	SE	Low	High	Prec
5/16	0.000	0.030	0.000	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.003	0.000	0.011	157.1%
5/17	0.000	0.030	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.006	0.004	0.000	0.014	133.6%
5/18	0.001	0.030	0.002	0.030	0.000	0.000	0.000	0.000	0.000	0.011	0.008	0.007	0.003	0.000	0.015	105.9%
5/19	0.001	0.031	0.020	0.030	0.000	0.000	0.000	0.000	0.038	0.011	0.021	0.014	0.004	0.004	0.024	71.8%
5/20	0.001	0.035	0.070	0.030	0.000	0.000	0.000	0.000	0.047	0.030	0.021	0.021	0.007	0.005	0.037	74.9%
5/21	0.001	0.038	0.119	0.038	0.000	0.000	0.000	0.000	0.080	0.048	0.021	0.031	0.012	0.005	0.058	83.9%
5/22	0.005	0.038	0.132	0.038	0.000	0.000	0.004	0.000	0.082	0.048	0.021	0.033	0.013	0.005	0.062	84.0%
5/23	0.005	0.052	0.132	0.045	0.000	0.000	0.051	0.011	0.082	0.066	0.028	0.043	0.012	0.016	0.070	63.4%
5/24	0.010	0.060	0.146	0.050	0.020	0.000	0.104	0.011	0.098	0.068	0.039	0.055	0.014	0.024	0.086	56.3%
5/25	0.021	0.062	0.146	0.050	0.020	0.019	0.173	0.030	0.106	0.071	0.039	0.067	0.016	0.031	0.103	53.4%
5/26	0.021	0.064	0.152	0.059	0.020	0.105	0.179	0.037	0.119	0.078	0.069	0.082	0.016	0.047	0.117	42.4%
5/27	0.021	0.064	0.162	0.059	0.222	0.105	0.179	0.059	0.131	0.100	0.077	0.107	0.018	0.066	0.148	38.0%
5/28	0.022	0.064	0.183	0.111	0.222	0.159	0.235	0.085	0.182	0.139	0.077	0.134	0.021	0.088	0.180	34.2%
5/29	0.022	0.080	0.213	0.118	0.284	0.214	0.250	0.139	0.240	0.151	0.077	0.162	0.025	0.106	0.219	34.6%
5/30	0.024	0.144	0.223	0.118	0.284	0.214	0.306	0.179	0.307	0.174	0.077	0.186	0.028	0.124	0.249	33.4%
5/31	0.026	0.193	0.244	0.118	0.284	0.214	0.376	0.204	0.329	0.182	0.077	0.204	0.032	0.134	0.274	34.4%
6/01	0.031	0.193	0.324	0.122	0.716	0.303	0.376	0.216	0.346	0.210	0.077	0.265	0.056	0.139	0.390	47.4%
6/02	0.031	0.256	0.362	0.129	0.863	0.341	0.407	0.236	0.369	0.240	0.132	0.306	0.066	0.159	0.453	48.0%
6/03	0.031	0.281	0.376	0.232	0.974	0.341	0.456	0.250	0.387	0.262	0.132	0.338	0.073	0.176	0.501	48.1%
6/04	0.031	0.312	0.428	0.250	0.974	0.495	0.581	0.250	0.454	0.311	0.132	0.383	0.076	0.213	0.553	44.3%
6/05	0.055	0.349	0.442	0.250	1.000	0.646	0.640	0.339	0.501	0.311	0.132	0.424	0.080	0.245	0.603	42.3%
6/06	0.080	0.390	0.442	0.260	1.000	0.646	0.754	0.354	0.501	0.353	0.132	0.447	0.082	0.265	0.628	40.7%
6/07	0.196	0.420	0.446	0.517	1.000	0.646	0.838	0.354	0.534	0.378	0.136	0.497	0.077	0.325	0.669	34.6%
6/08	0.266	0.420	0.468	0.535	1.000	0.646	0.838	0.393	0.554	0.416	0.178	0.519	0.072	0.359	0.680	30.9%
6/09	0.266	0.440	0.482	0.551	1.000	0.646	0.966	0.399	0.568	0.427	0.240	0.544	0.075	0.377	0.711	30.7%
6/10	0.312	0.475	0.496	0.590	1.000	0.646	0.966	0.436	0.598	0.466	0.240	0.566	0.072	0.406	0.726	28.3%
6/11	0.351	0.596	0.528	0.621	1.000	0.646	0.966	0.476	0.624	0.497	0.240	0.595	0.069	0.442	0.748	25.7%
6/12	0.397	0.610	0.544	0.621	1.000	0.646	0.966	0.519	0.634	0.497	0.275	0.610	0.065	0.465	0.755	23.7%
6/13	0.491	0.638	0.544	0.621	1.000	0.646	0.966	0.540	0.634	0.513	0.343	0.631	0.059	0.499	0.762	20.8%
6/14	0.552	0.665	0.581	0.621	1.000	0.646	1.000	0.540	0.658	0.527	0.387	0.653	0.057	0.526	0.779	19.5%

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Appendix B3.-Page 2 of 2.

	Daily cumulative proportions [P(t)] by year of harvest by unguided anglers											1986-1996		95% Confidence Interval		Rel[a]
Date	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Mean	SE	Low	High	Prec
6/15	0.648	0.665	0.621	0.621	1.000	0.646	1.000	0.540	0.658	0.534	0.445	0.671	0.053	0.553	0.789	17.6%
6/16	0.648	0.699	0.655	0.621	1.000	0.646	1.000	0.548	0.667	0.546	0.514	0.686	0.050	0.575	0.797	16.2%
6/17	0.660	0.722	0.712	0.632	1.000	0.646	1.000	0.567	0.700	0.700	0.592	0.721	0.044	0.623	0.819	13.6%
6/18	0.665	0.742	0.731	0.672	1.000	0.646	1.000	0.580	0.706	0.741	0.735	0.747	0.041	0.657	0.837	12.1%
6/19	0.696	0.828	0.761	0.672	1.000	0.646	1.000	0.620	0.715	0.741	0.750	0.766	0.039	0.680	0.853	11.3%
6/20	0.739	0.867	0.761	0.733	1.000	0.646	1.000	0.628	0.715	0.761	0.750	0.782	0.038	0.698	0.865	10.7%
6/21	0.760	0.911	0.789	0.764	1.000	0.646	1.000	0.628	0.731	0.773	0.767	0.797	0.038	0.713	0.881	10.5%
6/22	0.787	0.911	0.806	0.781	1.000	0.646	1.000	0.645	0.735	0.818	0.776	0.809	0.036	0.729	0.890	10.0%
6/23	0.787	0.915	0.818	0.866	1.000	0.646	1.000	0.650	0.735	0.818	0.866	0.827	0.036	0.746	0.908	9.8%
6/24	0.819	0.927	0.843	0.915	1.000	0.646	1.000	0.662	0.749	0.830	0.899	0.845	0.036	0.764	0.926	9.6%
6/25	0.853	0.946	0.872	0.941	1.000	0.646	1.000	0.688	0.770	0.846	0.934	0.863	0.036	0.783	0.943	9.3%
6/26	0.883	0.964	0.895	0.941	1.000	0.646	1.000	0.752	0.832	0.846	0.934	0.881	0.033	0.808	0.954	8.3%
~~6/27~~	~~0.951~~	~~0.978~~	~~0.895~~	~~0.983~~	~~1.000~~	~~0.646~~	~~1.000~~	~~0.835~~	~~0.832~~	~~0.910~~	~~0.934~~	~~0.906~~	~~0.032~~	~~0.835~~	~~0.976~~	~~7.8%~~
6/28	0.991	1.000	0.957	1.000	1.000	0.792	1.000	0.835	0.885	0.948	0.934	0.940	0.022	0.891	0.989	5.2%
6/29	1.000	1.000	0.983	1.000	1.000	0.938	1.000	0.955	0.936	0.983	0.952	0.977	0.008	0.959	0.995	1.8%
6/30	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.977	0.008	0.959	0.995	1.8%

[a] Relative precision.

Appendix B4.-Historical daily cumulative proportions of the catch of chinook salmon by unguided anglers during the return of early-run chinook salmon to the Kenai River, 1986-1996.

	Daily cumulative proportions													95% Confidence		
	[P(t)] by year of catch by unguided anglers											1986-1996		Interval		Rel[a]
Date	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Mean	SE	Low	High	Prec
5/16	0.000	0.023	0.000	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.002	0.000	0.008	158.0%
5/17	0.000	0.024	0.000	0.022	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.005	0.003	0.000	0.011	130.9%
5/18	0.001	0.024	0.003	0.022	0.000	0.000	0.000	0.000	0.000	0.012	0.004	0.006	0.003	0.000	0.012	101.8%
5/19	0.001	0.025	0.015	0.022	0.000	0.000	0.000	0.000	0.052	0.018	0.012	0.013	0.005	0.002	0.024	82.2%
5/20	0.001	0.036	0.048	0.022	0.000	0.000	0.000	0.000	0.061	0.032	0.012	0.019	0.007	0.004	0.034	77.0%
5/21	0.001	0.039	0.111	0.029	0.000	0.000	0.000	0.000	0.086	0.055	0.012	0.030	0.012	0.004	0.057	86.5%
5/22	0.003	0.039	0.121	0.029	0.000	0.000	0.004	0.005	0.088	0.055	0.016	0.033	0.012	0.006	0.060	83.0%
5/23	0.004	0.053	0.121	0.034	0.000	0.000	0.026	0.016	0.088	0.070	0.020	0.039	0.012	0.013	0.066	67.7%
5/24	0.010	0.060	0.147	0.038	0.007	0.000	0.048	0.016	0.101	0.073	0.026	0.048	0.014	0.017	0.078	63.6%
5/25	0.026	0.064	0.147	0.038	0.007	0.004	0.133	0.027	0.112	0.078	0.026	0.060	0.015	0.026	0.094	56.5%
5/26	0.026	0.072	0.152	0.045	0.007	0.024	0.135	0.034	0.124	0.083	0.043	0.068	0.015	0.034	0.101	49.2%
5/27	0.026	0.072	0.159	0.045	0.082	0.024	0.135	0.049	0.138	0.099	0.047	0.080	0.014	0.048	0.111	39.8%
5/28	0.027	0.072	0.175	0.084	0.100	0.037	0.158	0.079	0.175	0.131	0.047	0.099	0.016	0.062	0.135	36.8%
5/29	0.028	0.098	0.200	0.105	0.122	0.049	0.169	0.122	0.234	0.142	0.047	0.120	0.019	0.076	0.163	36.3%
5/30	0.029	0.165	0.209	0.105	0.122	0.062	0.200	0.177	0.292	0.157	0.047	0.142	0.024	0.089	0.195	37.2%
5/31	0.031	0.220	0.223	0.105	0.122	0.062	0.236	0.208	0.310	0.172	0.047	0.158	0.027	0.097	0.219	38.4%
6/01	0.035	0.220	0.280	0.108	0.281	0.094	0.236	0.223	0.333	0.191	0.047	0.186	0.030	0.119	0.254	36.3%
6/02	0.035	0.246	0.331	0.114	0.420	0.103	0.283	0.243	0.360	0.215	0.078	0.221	0.038	0.137	0.305	38.1%
6/03	0.035	0.288	0.346	0.207	0.484	0.103	0.309	0.297	0.377	0.241	0.078	0.251	0.041	0.160	0.343	36.5%
6/04	0.035	0.306	0.390	0.227	0.484	0.174	0.386	0.297	0.435	0.281	0.083	0.282	0.043	0.186	0.377	33.9%
6/05	0.055	0.335	0.403	0.227	0.484	0.222	0.411	0.384	0.473	0.281	0.092	0.306	0.044	0.209	0.403	31.8%
6/06	0.090	0.373	0.403	0.256	0.484	0.225	0.458	0.411	0.473	0.326	0.092	0.326	0.043	0.230	0.422	29.5%
6/07	0.194	0.398	0.406	0.481	0.484	0.234	0.510	0.411	0.508	0.348	0.094	0.370	0.042	0.276	0.463	25.3%
6/08	0.257	0.398	0.422	0.519	0.484	0.255	0.510	0.441	0.524	0.384	0.118	0.392	0.039	0.304	0.480	22.4%
6/09	0.257	0.418	0.436	0.531	0.528	0.272	0.589	0.453	0.545	0.399	0.152	0.416	0.042	0.324	0.509	22.2%
6/10	0.357	0.460	0.447	0.566	0.538	0.272	0.594	0.483	0.566	0.440	0.152	0.443	0.041	0.352	0.535	20.6%
6/11	0.398	0.554	0.485	0.590	0.538	0.289	0.597	0.528	0.600	0.465	0.152	0.472	0.043	0.377	0.568	20.2%
6/12	0.446	0.570	0.497	0.590	0.549	0.343	0.597	0.562	0.610	0.465	0.172	0.491	0.040	0.402	0.580	18.2%
6/13	0.530	0.597	0.497	0.590	0.550	0.357	0.610	0.586	0.610	0.475	0.210	0.510	0.038	0.426	0.594	16.5%
6/14	0.594	0.626	0.544	0.590	0.550	0.357	0.637	0.586	0.631	0.487	0.263	0.533	0.036	0.452	0.614	15.2%

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Appendix B4.-Page 2 of 2.

	Daily cumulative proportions [P(t)] by year of catch by unguided anglers											1986-1996		95% Confidence Interval		Rel[a]
Date	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Mean	SE	Low	High	Prec
6/15	0.668	0.626	0.579	0.612	0.550	0.368	0.637	0.600	0.631	0.493	0.306	0.552	0.035	0.473	0.630	14.2%
6/16	0.668	0.647	0.622	0.618	0.550	0.368	0.651	0.607	0.643	0.506	0.418	0.573	0.030	0.505	0.641	11.8%
6/17	0.676	0.683	0.660	0.635	0.667	0.368	0.651	0.631	0.673	0.671	0.462	0.616	0.031	0.547	0.685	11.2%
6/18	0.680	0.702	0.696	0.676	0.667	0.396	0.651	0.642	0.678	0.712	0.785	0.662	0.029	0.598	0.727	9.8%
6/19	0.699	0.786	0.729	0.676	0.724	0.427	0.651	0.667	0.684	0.712	0.793	0.686	0.029	0.621	0.751	9.5%
6/20	0.725	0.839	0.729	0.752	0.742	0.572	0.719	0.672	0.684	0.725	0.819	0.725	0.022	0.677	0.773	6.6%
6/21	0.746	0.881	0.756	0.785	0.821	0.572	0.729	0.672	0.694	0.748	0.828	0.748	0.025	0.692	0.805	7.6%
6/22	0.764	0.881	0.767	0.810	0.821	0.885	0.729	0.691	0.697	0.792	0.845	0.789	0.020	0.744	0.834	5.7%
6/23	0.764	0.885	0.778	0.883	0.821	0.895	0.729	0.694	0.699	0.792	0.907	0.804	0.024	0.751	0.858	6.6%
6/24	0.789	0.894	0.827	0.936	0.905	0.895	0.768	0.710	0.709	0.821	0.929	0.835	0.025	0.779	0.891	6.7%
6/25	0.824	0.917	0.856	0.955	0.905	0.895	0.768	0.726	0.733	0.840	0.949	0.852	0.025	0.797	0.907	6.5%
6/26	0.844	0.955	0.880	0.955	0.958	0.895	0.778	0.789	0.827	0.840	0.949	0.879	0.021	0.833	0.925	5.2%
6/27	0.920	0.976	0.880	0.987	0.977	0.895	0.797	0.869	0.827	0.920	0.949	0.909	0.019	0.867	0.951	4.6%
6/28	0.980	1.000	0.952	1.000	0.977	0.928	0.824	0.869	0.863	0.965	0.949	0.937	0.018	0.897	0.977	4.3%
6/29	1.000	1.000	0.969	1.000	1.000	0.973	0.824	0.944	0.927	0.989	0.969	0.963	0.016	0.928	0.998	3.7%
6/30	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%

[a] Relative precision.

Appendix B5.-Historical daily cumulative proportions of the effort by guided anglers during the return of early-run chinook salmon to the Kenai River, 1986-1996.

	Daily cumulative proportions [P(t)] by year of guided angler effort											1986-1996		95% Confidence Interval		Rel[a]
Date	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Mean	SE	Low	High	Prec
5/16	0.000	0.005	0.000	0.003	0.006	0.006	0.000	0.000	0.000	0.000	0.002	0.002	0.001	0.000	0.004	84.1%
5/17	0.005	0.011	0.005	0.006	0.011	0.011	0.000	0.000	0.002	0.005	0.004	0.005	0.001	0.003	0.008	51.6%
5/18	0.010	0.011	0.009	0.010	0.018	0.017	0.000	0.000	0.004	0.011	0.013	0.009	0.002	0.005	0.013	42.6%
5/19	0.010	0.016	0.014	0.015	0.052	0.022	0.015	0.000	0.022	0.032	0.017	0.019	0.004	0.010	0.028	46.0%
5/20	0.015	0.019	0.027	0.034	0.075	0.022	0.030	0.000	0.031	0.047	0.017	0.029	0.006	0.016	0.042	45.3%
5/21	0.020	0.024	0.064	0.041	0.075	0.028	0.037	0.000	0.052	0.073	0.025	0.040	0.007	0.024	0.056	39.9%
5/22	0.023	0.029	0.089	0.041	0.087	0.034	0.045	0.026	0.058	0.073	0.035	0.049	0.007	0.033	0.065	33.1%
5/23	0.027	0.055	0.089	0.048	0.103	0.039	0.053	0.034	0.058	0.082	0.043	0.057	0.007	0.041	0.074	28.1%
5/24	0.042	0.080	0.100	0.054	0.119	0.061	0.083	0.034	0.065	0.100	0.050	0.072	0.008	0.054	0.090	25.3%
5/25	0.072	0.087	0.108	0.058	0.141	0.068	0.162	0.036	0.088	0.123	0.067	0.092	0.011	0.066	0.117	27.9%
5/26	0.083	0.095	0.115	0.067	0.231	0.136	0.158	0.061	0.103	0.135	0.083	0.115	0.015	0.082	0.148	28.6%
~~5/27~~	~~0.084~~	~~0.101~~	~~0.130~~	~~0.104~~	~~0.318~~	~~0.149~~	~~0.183~~	~~0.079~~	~~0.127~~	~~0.168~~	~~0.091~~	~~0.140~~	0.021	~~0.094~~	~~0.185~~	~~32.8%~~
5/28	0.085	0.109	0.150	0.158	0.371	0.156	0.197	0.103	0.148	0.193	0.102	0.161	0.024	0.108	0.214	32.8%
5/29	0.089	0.118	0.207	0.175	0.388	0.166	0.202	0.135	0.172	0.200	0.119	0.179	0.024	0.126	0.233	29.8%
5/30	0.094	0.180	0.222	0.183	0.413	0.178	0.237	0.174	0.198	0.216	0.128	0.202	0.024	0.148	0.257	26.9%
5/31	0.110	0.218	0.247	0.192	0.432	0.192	0.243	0.198	0.217	0.233	0.140	0.220	0.025	0.165	0.275	25.0%
6/01	0.121	0.218	0.267	0.200	0.453	0.246	0.243	0.217	0.233	0.251	0.158	0.237	0.025	0.181	0.293	23.7%
6/02	0.121	0.238	0.304	0.209	0.506	0.297	0.298	0.236	0.248	0.271	0.177	0.264	0.029	0.199	0.330	24.8%
6/03	0.129	0.259	0.329	0.276	0.584	0.297	0.321	0.250	0.262	0.295	0.177	0.289	0.035	0.212	0.366	26.6%
6/04	0.140	0.279	0.416	0.309	0.584	0.324	0.345	0.259	0.294	0.314	0.199	0.315	0.035	0.237	0.392	24.6%
6/05	0.157	0.310	0.433	0.309	0.617	0.401	0.363	0.293	0.316	0.314	0.213	0.339	0.036	0.258	0.419	23.8%
6/06	0.177	0.396	0.433	0.332	0.655	0.404	0.412	0.317	0.316	0.344	0.228	0.365	0.037	0.281	0.448	22.8%
6/07	0.267	0.438	0.466	0.360	0.656	0.416	0.457	0.317	0.357	0.373	0.255	0.396	0.034	0.322	0.471	18.9%
6/08	0.325	0.438	0.486	0.387	0.664	0.437	0.457	0.347	0.390	0.398	0.280	0.419	0.030	0.351	0.487	16.2%
6/09	0.325	0.474	0.496	0.421	0.686	0.452	0.518	0.377	0.423	0.441	0.315	0.448	0.031	0.380	0.516	15.3%
6/10	0.358	0.502	0.509	0.471	0.694	0.452	0.556	0.442	0.546	0.475	0.315	0.484	0.030	0.416	0.551	14.0%
6/11	0.386	0.530	0.569	0.510	0.694	0.465	0.595	0.482	0.597	0.491	0.354	0.516	0.029	0.450	0.581	12.7%
6/12	0.415	0.564	0.593	0.510	0.703	0.485	0.617	0.527	0.604	0.491	0.388	0.536	0.028	0.474	0.598	11.6%
6/13	0.487	0.630	0.593	0.537	0.705	0.495	0.639	0.555	0.604	0.527	0.429	0.564	0.024	0.510	0.617	9.5%
6/14	0.566	0.658	0.625	0.551	0.714	0.510	0.659	0.555	0.648	0.541	0.478	0.591	0.022	0.542	0.641	8.4%

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Appendix B5.-Page 2 of 2.

Date	Daily cumulative proportions [P(t)] by year of guided angler effort											1986-1996		95% Confidence Interval		Rel[a]
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Mean	SE	Low	High	Prec
6/15	0.640	0.658	0.648	0.575	0.727	0.524	0.659	0.587	0.675	0.567	0.520	0.616	0.020	0.572	0.661	7.2%
6/16	0.640	0.674	0.678	0.598	0.746	0.553	0.689	0.617	0.686	0.595	0.559	0.639	0.018	0.599	0.680	6.4%
6/17	0.677	0.702	0.707	0.642	0.766	0.553	0.712	0.646	0.697	0.622	0.578	0.664	0.019	0.621	0.706	6.4%
6/18	0.699	0.726	0.741	0.668	0.766	0.569	0.737	0.678	0.719	0.650	0.599	0.686	0.019	0.645	0.728	6.0%
6/19	0.720	0.749	0.763	0.668	0.785	0.577	0.759	0.710	0.740	0.650	0.640	0.706	0.019	0.663	0.749	6.1%
6/20	0.746	0.798	0.763	0.694	0.800	0.602	0.781	0.740	0.740	0.683	0.679	0.730	0.018	0.689	0.770	5.5%
6/21	0.791	0.834	0.790	0.726	0.813	0.617	0.804	0.740	0.770	0.714	0.714	0.756	0.019	0.714	0.797	5.5%
6/22	0.815	0.834	0.812	0.750	0.829	0.675	0.804	0.777	0.792	0.747	0.774	0.782	0.014	0.751	0.813	4.0%
6/23	0.815	0.847	0.832	0.779	0.869	0.697	0.841	0.807	0.814	0.776	0.808	0.808	0.014	0.777	0.839	3.8%
6/24	0.833	0.864	0.849	0.827	0.907	0.697	0.861	0.838	0.844	0.802	0.823	0.831	0.016	0.796	0.866	4.2%
6/25	0.858	0.888	0.898	0.883	0.907	0.707	0.884	0.872	0.872	0.828	0.872	0.861	0.017	0.824	0.898	4.3%
6/26	0.888	0.920	0.931	0.883	0.925	0.722	0.921	0.904	0.897	0.828	0.898	0.884	0.018	0.843	0.924	4.6%
6/27	0.913	0.943	0.931	0.923	0.943	0.736	0.958	0.936	0.897	0.877	0.921	0.907	0.018	0.866	0.948	4.5%
6/28	0.960	0.980	0.959	0.953	0.956	0.811	0.975	0.936	0.940	0.923	0.947	0.940	0.014	0.909	0.971	3.3%
6/29	1.000	0.980	0.984	0.980	0.972	0.918	0.975	0.968	0.968	0.964	0.975	0.971	0.006	0.958	0.985	1.4%
6/30	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%

[a] Relative precision.

Appendix B6.-Historical daily cumulative proportions of the harvest of chinook salmon by guided anglers during the return of early-run chinook salmon to the Kenai River, 1986-1996.

	Daily cumulative proportions [P(t)] by year of harvest by guided anglers											1986-1996		95% Confidence Interval		Rel[a]
Date	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Mean	SE	Low	High	Prec
5/16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
5/17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.000	0.001	0.001	0.000	0.003	222.8%
5/18	0.000	0.000	0.008	0.007	0.000	0.000	0.000	0.000	0.000	0.014	0.011	0.004	0.002	0.000	0.007	99.4%
5/19	0.000	0.000	0.016	0.018	0.000	0.000	0.000	0.000	0.030	0.026	0.014	0.009	0.003	0.002	0.017	83.1%
5/20	0.000	0.000	0.025	0.025	0.025	0.000	0.049	0.000	0.040	0.026	0.014	0.018	0.005	0.007	0.030	62.3%
5/21	0.000	0.003	0.025	0.029	0.025	0.000	0.049	0.000	0.050	0.065	0.027	0.025	0.007	0.010	0.040	61.4%
5/22	0.009	0.003	0.069	0.029	0.064	0.000	0.049	0.009	0.053	0.065	0.035	0.035	0.008	0.017	0.053	50.8%
5/23	0.015	0.012	0.069	0.035	0.098	0.000	0.076	0.013	0.053	0.065	0.041	0.043	0.010	0.022	0.065	48.9%
5/24	0.020	0.022	0.097	0.042	0.112	0.000	0.076	0.013	0.061	0.081	0.045	0.052	0.011	0.027	0.076	47.5%
5/25	0.027	0.028	0.121	0.042	0.203	0.000	0.269	0.015	0.105	0.105	0.057	0.088	0.025	0.032	0.145	64.1%
5/26	0.031	0.047	0.131	0.042	0.241	0.017	0.264	0.045	0.114	0.111	0.069	0.101	0.025	0.045	0.157	55.6%
5/27	0.054	0.047	0.164	0.042	0.280	0.066	0.341	0.084	0.142	0.138	0.077	0.130	0.030	0.064	0.197	51.1%
5/28	0.060	0.049	0.175	0.054	0.280	0.066	0.380	0.124	0.150	0.149	0.103	0.145	0.031	0.075	0.214	48.3%
5/29	0.070	0.061	0.195	0.057	0.334	0.145	0.406	0.152	0.159	0.149	0.123	0.168	0.033	0.094	0.242	44.0%
5/30	0.080	0.125	0.195	0.072	0.571	0.186	0.474	0.192	0.175	0.164	0.134	0.215	0.048	0.109	0.322	49.6%
5/31	0.095	0.180	0.195	0.110	0.669	0.186	0.496	0.226	0.221	0.183	0.147	0.246	0.053	0.128	0.364	47.9%
6/01	0.135	0.180	0.246	0.166	0.762	0.224	0.496	0.303	0.245	0.203	0.167	0.284	0.056	0.159	0.409	44.0%
6/02	0.135	0.206	0.280	0.252	0.782	0.584	0.651	0.319	0.258	0.234	0.175	0.352	0.065	0.207	0.498	41.2%
6/03	0.135	0.297	0.298	0.294	0.890	0.584	0.694	0.335	0.279	0.250	0.175	0.385	0.071	0.227	0.542	41.0%
6/04	0.135	0.329	0.338	0.322	0.890	0.685	0.743	0.341	0.311	0.277	0.179	0.414	0.074	0.250	0.578	39.7%
6/05	0.185	0.403	0.366	0.322	0.936	0.765	0.780	0.375	0.333	0.277	0.179	0.447	0.078	0.274	0.620	38.7%
6/06	0.235	0.428	0.366	0.362	1.000	0.765	0.925	0.380	0.333	0.325	0.191	0.483	0.084	0.295	0.670	38.8%
6/07	0.312	0.455	0.374	0.419	1.000	0.765	0.992	0.380	0.367	0.343	0.224	0.512	0.083	0.327	0.696	36.0%
6/08	0.355	0.455	0.393	0.475	1.000	0.765	0.992	0.418	0.399	0.366	0.251	0.533	0.079	0.358	0.709	32.9%
6/09	0.355	0.490	0.423	0.551	1.000	0.765	0.992	0.444	0.417	0.420	0.319	0.561	0.074	0.397	0.726	29.3%
6/10	0.404	0.539	0.450	0.568	1.000	0.765	0.992	0.514	0.588	0.450	0.319	0.599	0.068	0.447	0.752	25.5%
6/11	0.463	0.580	0.481	0.589	1.000	0.765	0.992	0.535	0.627	0.456	0.366	0.623	0.064	0.481	0.766	22.8%
6/12	0.480	0.593	0.494	0.589	1.000	0.765	0.992	0.570	0.633	0.456	0.421	0.636	0.061	0.500	0.771	21.3%
6/13	0.539	0.617	0.494	0.614	1.000	0.765	0.992	0.587	0.633	0.471	0.481	0.654	0.057	0.527	0.781	19.4%
6/14	0.576	0.648	0.556	0.642	1.000	0.765	0.992	0.587	0.716	0.471	0.558	0.683	0.053	0.565	0.800	17.2%

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Appendix B6.-Page 2 of 2.

	Daily cumulative proportions [P(t)] by year of harvest by guided anglers											1986-1996		95% Confidence Interval		Rel[a]
Date	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Mean	SE	Low	High	Prec
6/15	0.612	0.648	0.596	0.665	1.000	0.765	0.992	0.600	0.730	0.495	0.603	0.700	0.049	0.591	0.810	15.6%
6/16	0.612	0.692	0.644	0.685	1.000	0.765	0.992	0.625	0.737	0.510	0.672	0.721	0.046	0.619	0.823	14.1%
6/17	0.635	0.770	0.675	0.691	1.000	0.765	0.992	0.674	0.747	0.626	0.715	0.754	0.039	0.667	0.840	11.5%
6/18	0.653	0.797	0.709	0.707	1.000	0.765	1.000	0.695	0.751	0.645	0.739	0.769	0.037	0.687	0.852	10.7%
6/19	0.692	0.833	0.747	0.707	1.000	0.765	1.000	0.709	0.753	0.645	0.811	0.787	0.035	0.708	0.866	10.0%
6/20	0.743	0.857	0.747	0.750	1.000	0.765	1.000	0.733	0.753	0.690	0.840	0.807	0.032	0.736	0.878	8.8%
6/21	0.758	0.863	0.792	0.807	1.000	0.765	1.000	0.733	0.773	0.718	0.840	0.823	0.029	0.757	0.888	8.0%
6/22	0.788	0.863	0.818	0.815	1.000	0.765	1.000	0.752	0.783	0.767	0.879	0.839	0.027	0.779	0.899	7.1%
6/23	0.788	0.872	0.837	0.832	1.000	0.765	1.000	0.768	0.791	0.784	0.904	0.849	0.026	0.791	0.907	6.8%
6/24	0.805	0.885	0.853	0.858	1.000	0.765	1.000	0.784	0.820	0.805	0.914	0.863	0.024	0.808	0.917	6.3%
6/25	0.845	0.919	0.869	0.903	1.000	0.765	1.000	0.819	0.858	0.832	0.971	0.889	0.023	0.837	0.941	5.8%
6/26	0.872	0.951	0.884	0.903	1.000	0.765	1.000	0.868	0.878	0.832	0.971	0.902	0.022	0.853	0.951	5.4%
6/27	0.911	0.972	0.884	0.979	1.000	0.765	1.000	0.917	0.878	0.888	0.979	0.925	0.021	0.877	0.972	5.1%
6/28	0.982	0.998	0.934	0.991	1.000	0.817	1.000	0.917	0.918	0.940	0.979	0.952	0.017	0.915	0.990	3.9%
6/29	1.000	0.998	0.973	1.000	1.000	0.900	1.000	0.932	0.954	0.988	0.994	0.976	0.010	0.954	0.999	2.3%
6/30	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%

[a] Relative precision.

Appendix B7.-Historical daily cumulative proportions of the catch of chinook salmon by guided anglers during the return of early-run chinook salmon to the Kenai River, 1986-1996.

	Daily cumulative proportions [P(t)] by year of catch by guided anglers											1986-1996		95% Confidence Interval		Rel[a]
Date	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Mean	SE	Low	High	Prec
5/16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
5/17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.000	0.001	0.001	0.000	0.002	222.8%
5/18	0.000	0.000	0.005	0.005	0.000	0.000	0.000	0.000	0.000	0.010	0.009	0.003	0.001	0.000	0.005	99.2%
5/19	0.000	0.000	0.011	0.014	0.000	0.000	0.000	0.000	0.033	0.027	0.011	0.009	0.004	0.001	0.017	91.9%
5/20	0.000	0.000	0.017	0.020	0.007	0.000	0.004	0.000	0.041	0.030	0.011	0.012	0.004	0.003	0.021	78.8%
5/21	0.000	0.004	0.017	0.024	0.007	0.000	0.004	0.000	0.050	0.063	0.021	0.017	0.006	0.003	0.032	83.6%
5/22	0.009	0.004	0.055	0.024	0.018	0.000	0.006	0.010	0.054	0.063	0.028	0.025	0.007	0.009	0.040	62.3%
5/23	0.014	0.011	0.055	0.028	0.027	0.000	0.008	0.015	0.054	0.064	0.034	0.028	0.006	0.014	0.043	50.8%
5/24	0.018	0.019	0.080	0.034	0.031	0.000	0.013	0.015	0.060	0.083	0.037	0.036	0.008	0.017	0.054	52.3%
5/25	0.025	0.023	0.105	0.034	0.069	0.000	0.097	0.017	0.094	0.100	0.047	0.056	0.012	0.030	0.082	46.8%
5/26	0.027	0.045	0.116	0.034	0.079	0.014	0.096	0.042	0.104	0.107	0.056	0.066	0.011	0.041	0.090	37.1%
~~5/27~~	0.042	~~0.045~~	~~0.148~~	~~0.034~~	~~0.090~~	~~0.046~~	~~0.101~~	~~0.079~~	~~0.135~~	~~0.131~~	~~0.063~~	~~0.083~~	~~0.012~~	~~0.056~~	~~0.111~~	~~33.3%~~
5/28	0.049	0.048	0.157	0.043	0.090	0.046	0.101	0.110	0.143	0.140	0.084	0.092	0.013	0.064	0.120	30.7%
5/29	0.057	0.060	0.174	0.046	0.105	0.082	0.104	0.141	0.158	0.140	0.104	0.107	0.013	0.078	0.135	27.1%
5/30	0.065	0.115	0.174	0.058	0.171	0.101	0.156	0.179	0.193	0.155	0.113	0.135	0.014	0.103	0.166	23.3%
5/31	0.082	0.161	0.209	0.088	0.198	0.101	0.162	0.212	0.234	0.173	0.124	0.159	0.016	0.123	0.194	22.5%
6/01	0.117	0.161	0.252	0.133	0.224	0.114	0.162	0.270	0.268	0.187	0.140	0.184	0.018	0.144	0.224	21.8%
6/02	0.117	0.199	0.293	0.202	0.235	0.235	0.241	0.282	0.307	0.209	0.148	0.224	0.018	0.185	0.264	17.5%
6/03	0.117	0.259	0.307	0.241	0.288	0.235	0.263	0.298	0.330	0.225	0.148	0.246	0.020	0.203	0.290	17.8%
6/04	0.117	0.297	0.352	0.271	0.288	0.287	0.263	0.309	0.370	0.248	0.151	0.268	0.023	0.217	0.319	19.0%
6/05	0.175	0.357	0.380	0.271	0.308	0.323	0.274	0.335	0.388	0.248	0.151	0.292	0.023	0.240	0.344	17.9%
6/06	0.232	0.388	0.380	0.309	0.326	0.335	0.283	0.342	0.388	0.282	0.161	0.312	0.021	0.265	0.358	15.0%
6/07	0.302	0.413	0.389	0.368	0.339	0.341	0.354	0.342	0.429	0.298	0.187	0.342	0.020	0.298	0.386	12.9%
6/08	0.342	0.413	0.409	0.421	0.353	0.375	0.354	0.378	0.456	0.319	0.211	0.367	0.020	0.323	0.410	12.0%
6/09	0.342	0.450	0.442	0.516	0.384	0.395	0.563	0.398	0.470	0.369	0.284	0.419	0.024	0.366	0.473	12.7%
6/10	0.384	0.501	0.470	0.530	0.439	0.395	0.659	0.465	0.618	0.397	0.284	0.467	0.032	0.395	0.540	15.5%
6/11	0.450	0.541	0.509	0.553	0.439	0.411	0.659	0.508	0.654	0.401	0.342	0.497	0.030	0.429	0.565	13.7%
6/12	0.471	0.555	0.518	0.553	0.481	0.458	0.692	0.542	0.658	0.401	0.416	0.522	0.028	0.461	0.584	11.8%
6/13	0.543	0.579	0.518	0.576	0.524	0.483	0.726	0.558	0.658	0.417	0.470	0.550	0.026	0.492	0.608	10.5%
6/14	0.574	0.609	0.569	0.603	0.572	0.553	0.758	0.558	0.721	0.417	0.561	0.590	0.027	0.530	0.651	10.2%

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Appendix B7.-Page 2 of 2.

	Daily cumulative proportions [P(t)] by year of catch by guided anglers											1986-1996		95% Confidence Interval		Rel[a]
Date	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Mean	SE	Low	High	Prec
6/15	0.605	0.609	0.603	0.628	0.610	0.589	0.758	0.574	0.738	0.434	0.627	0.616	0.025	0.559	0.672	9.2%
6/16	0.605	0.661	0.651	0.646	0.648	0.671	0.804	0.603	0.745	0.450	0.700	0.653	0.027	0.593	0.713	9.2%
6/17	0.620	0.745	0.682	0.657	0.674	0.671	0.826	0.654	0.752	0.582	0.734	0.691	0.021	0.645	0.737	6.7%
6/18	0.638	0.784	0.722	0.683	0.674	0.689	0.826	0.685	0.755	0.598	0.760	0.710	0.020	0.666	0.755	6.3%
6/19	0.673	0.841	0.759	0.683	0.694	0.724	0.834	0.697	0.758	0.598	0.825	0.735	0.023	0.684	0.787	7.0%
6/20	0.714	0.868	0.759	0.746	0.762	0.734	0.866	0.729	0.758	0.643	0.851	0.766	0.021	0.720	0.813	6.1%
6/21	0.729	0.876	0.799	0.801	0.803	0.812	0.890	0.729	0.773	0.672	0.851	0.794	0.020	0.750	0.838	5.6%
6/22	0.753	0.876	0.824	0.819	0.819	0.869	0.890	0.745	0.782	0.722	0.893	0.818	0.018	0.777	0.858	5.0%
6/23	0.753	0.885	0.837	0.840	0.844	0.889	0.912	0.762	0.788	0.747	0.913	0.834	0.019	0.792	0.876	5.1%
6/24	0.774	0.899	0.863	0.870	0.868	0.889	0.927	0.779	0.814	0.767	0.927	0.852	0.018	0.812	0.893	4.7%
6/25	0.827	0.928	0.879	0.911	0.868	0.896	0.927	0.819	0.854	0.788	0.973	0.879	0.017	0.842	0.916	4.2%
6/26	0.850	0.956	0.892	0.911	0.925	0.903	0.962	0.878	0.873	0.788	0.973	0.901	0.016	0.865	0.937	4.0%
6/27	0.919	0.975	0.892	0.980	0.949	0.914	0.981	0.919	0.873	0.855	0.979	0.931	0.014	0.900	0.961	3.3%
6/28	0.984	0.999	0.937	0.990	0.968	0.931	0.990	0.919	0.928	0.929	0.979	0.959	0.009	0.939	0.980	2.1%
6/29	1.000	0.999	0.973	1.000	0.982	0.966	0.990	0.942	0.960	0.992	0.995	0.982	0.006	0.969	0.995	1.3%
6/30	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%

[a] Relative precision.